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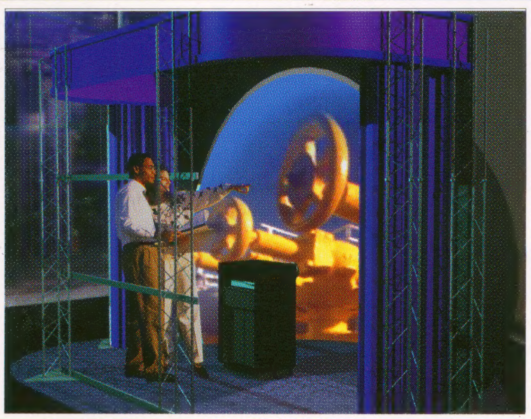

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

03

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HYDROPONICS DO YOU GROW YOUR OWN? We have a full colour hydroponics catalogue available containing nutrients, pumps, fittings, enviromental control, light fittings,

WINDOWS 95 CD As supplied with Hewlet Packard PC's these CD's have all the window files on them and were intended to be used to restore windows on a PC after a crash etc.£15 REF SX06

SATELLITE MODULATOR MODULES prices from just 9p Surface mount modulators full of components. Fitted with an F type connector and a uhf type connector. Pack of 100 £9.95 ref SS20

PROJECT BOXES
Another bargain for you are these smart ABS project boxes, smart two piece screw together case measuring approx 6"x5"x2" complete with panel mounted LED. Inside you will find loads of free bits, tape heads, motors, chips resistors, transistors etc. Pack of 20 £19.95 ref MD2

REMOTE HEATING CONTROLLERS WITH 30A MAINS RELAY from just 99p These units were designed to be plugged into a telephone socket. You then called the phone and some how it turned the heating on. Each box contains lots of bits including a mains 30A relay. pack of 20 £20 ref SS34

.TALKING COINBOXES Prices from just 95p These units were made to convert standard telephones into pay phones, complete with coinslot assemblies and switches etc. OFFERED TO YOU AT A BARGAIN PRICE BECAUSE WE NEED THE SPACE! Pack of 10 £19 ref SS29

AC MOTOR BONANZA! prices from just 59p Again we have piles and piles of these brand new mixed motors which we need to clear in bulk at ridiculous prices! Pack of 50 for £30 ref SS13

PIR CAMERA Built in CCTV camera (composite output) IR strobe light,PIR detector and battery backup. Designed to 'squirt' pictures down the 'phone line but works well as a standalone unit. Bargain price £49.95 ref SS81, 3 or more £44.95 ref SS80.These units are brand new modules designed to take 'pictures' of intruders and then transmit the pictures down the telephone line. The PIR detects the intruder, fires the strobe light this ensures a perfect picture even in total darkness. The picture is stored in memory inside the module and then sent by modem (not included) down the telephone line. The units also have a nicad battery pack included presumably to maintain operation in the event of mains power failure. Output from the camera is standard b/w composite 320x240 pixels with a 90x65 degree field of view, the picture quality is excellent.Each PIR also contains a video capture and compression unit.The infra red strobe has a range of 15m.The pir has a range of 12m.Power requirements are 12v dc 400mA. Power supplies available at £5 ref SS80The units are supplied with connection details etc but we do not have any information on using the compression and capture unit or interfacing to modems etc.The units do have operational PIR's, strobes and camera's (camera is 12vdc and gives out standard composite 1v p-p video) how you adapt these to work together is entirely up to you!Retail price for the units was in excess of £200 each sale price £39.95ref SS81JPower supplies £5 ref SS80

TELEPHONES Just in this week is a huge delivery of telephones, all brand new and boxed. Two piece construction with the following features- Illuminated keypad, tone or pulse (switchable), reacall, redial and pause, high/low and off ringer switch and quality construction. finished in a smart off white colour and is supplied with a standard international lead (same as US or modems) if you wish to have a BT lead supplied to convert the phones these are also available at £1.55 each ref BTLX **Phones £4.99 each ref PH2 10 off £30 ref SS2**

3HP MAINS MOTORS Single phase 240v, brand new, 2 pole, 340x180mm, 2850 rpm, builtin automatice reset overload protector, keyed shaft (40x16mm)Made by Leeson. £99 each ref LEE1

BUILD YOU OWN WINDFARM FROM SCRAP
New publication gives step by step guide to building wind generators and propellors. Armed with this publication and a good local scrap yard could make you self sufficient in electricity! £12 ref LOT81

CHIEFTAN TANK DOUBLE LASERS 9 WATT+3 WATT+LASER OPTICS Could be adapted for laser listener, long range communications etc Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignement. 7 mile range, no circuit diagrams due to MOD, new price £50,000? us? £199. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc, 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets. £199 Ref LOT4.

MAGNETIC CREDIT CARD READERS AND ENCODING MANUAL £9.95 Cased with flyleads, designed to read standard credit cards! complete with control elctronics PCB and manual covering everything you could want to know about whats hidden in that magnetic strip on your card! just £9.95 ref BAR31

HI POWER ZENON VARIABLE STROBES Useful 12v PCB fitted with hi power strobe tube and control electronics and speed control potentiometer. Perfect for interesting projects etc 70x55mm 12vdc operation. £6 ea ref FLS1, pack of 10 £49 ref FLS2

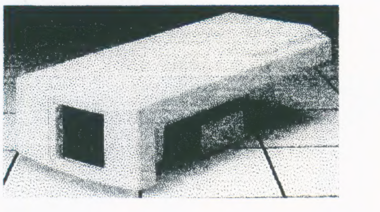
CENTRAL POINT PC TOOLS Award winning software, 1,300 virus checker, memory optimiser, disc optimiser, file compression, low level formatting, backup scheduler, disk defragmenter, undelete, 4 calculators, D base, disc editor, over 40 viewers, remote computing, password protection, encryption, comprehensive manual supplied etc £8 ref lot 97 3.5" disks. £10 ref LOT97

VIDEO PROCESSOR UNITS?/6v 10AH BATTS/ 24V 8A TX Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear. Inside 2 x 6v 10AH sealed lead acid batts, pcb's and a 8A? 24v torroidial transformer (mains in). sold as seen, may have one or two broken knobs etc due to poor storage. £15.99 ref VP2

DIFFERENTIAL THERMOSTAT KIT Perfect for heatrecovery, solar systems, boiler efficiency etc. Two sensors will operate a relay when a temp difference (adjustable) is detected. All components and pcb. £29 ref LOT93

SOLAR WATER HEATING PLANS £6 REF SOLP

PC POWER SUPPLIES PACK OF 8 £9.95
Thats right! 8 power supplies for £9.95! These are all fan cooled (usually 12v) our choice of specs etc, and are sold as seen. But worth it for the fans alone! ref XX17



COLOUR CCTV VIDEO CAMERAS From £99

Works with most modern video's, TV's, Composite monitors, video grabber cards. Pal, 1v P-P, composite, 75ohm, 1/3" CCD, 4mm F2.8, 500x582, 12vdc, mounting bracket, auto shutter, 100x50x180mm, 3 months warranty,1 off price £119 ref XEF150, 10 or more £99 ea 100+ £89

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SMOKE ALARMS Mains powered, made by the famous Gent company, easy fit next to light fittings , power point. Pack of 5 £15 ref SS23, pack of 12 £24 ref SS24

4AH D SIZE NICADS pack of 4 £10 ref 4AHPK

ELECTRIC FENCE KIT Everything you need to build a 12vdc electric fence, complete with 200m of fence wire. £49 ref AR2

SENDER KIT Contains all components to build a A/V transmitter complete with case £35 ref VSXX2

33 KILO LIFT MAGNET Neodynium, 32mm £15 ref MAG33

10 WATT SOLAR PANEL Amorphous silicon panel fitted in a anodized aluminium frame. Panel measures 3' by 1' with screw terminals for easy connection. . **3' x 1' solar panel £55 ref MAG45 Unframed 4 pack (3'x1') £58.99 ref SOLX**

12V SOLAR POWERED WATER PUMP Perfect for many 12v DC uses, ranging from solar fountains to hydroponics! Small and compact yet powerful.works direct from our 10 watt solar panel in bright sun. Max hd:l7 ft Max flow = 8 Lpm,1 .5A Ref AC8 £18.99

SOLAR ENERGY BANK KIT 50x 6"x12" 6v solar panels(amorphous)+50 diodes £99 ref EF112

PINHOLE CAMERA MODULE WITH AUDIO!
Superb board camera with on board sound! extra small just 28mm square (including microphone) ideal for covert surveillance. Can be hidden inside anything , even a matchbox! Complete with 15 metre cable, psu and tv/vcr connnectors. £49.95 ref CC6J

SOLAR MOTORS Tiny motors which run quite happily on voltages from3-12vdc. Works on our 6v amorphous 6" panels and you can run them from the sun! 32mm dia 20mm thick. £1.50 each

WALKIE TALKIES 1 MILE RANGE £37/PAIR REF MAG30

LIQUID CRYSTAL DISPLAYS Bargain prices,
20 character 2 line, 83x19mm £3.99 ref SMC2024A
16 character 4 line, 62x25mm £5.99 ref SMC1640A
40 character 1 line 154x16mm £6.00 ref SMC4011A

LM255X HITACHI LAPTOP SCREENS 240x100mm, 640x200 dots. New with data £15 ref LM2

SEALED LEAD ACID BATTERIES 12V 7AH, S/HAND PACK OF 4 £10 REF XX1

YOUR HOME COULD BE SELF SUFFICENT IN ELECTRICITY Comprehensive plans with loads of info on designing systems, panels, control electronics etc £7 ref PV1

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200 WATT INVERTERS plugs straight into your car cigarette lighter socket and is fitted with a 13A socket so you can run your mains operated devices from your car battery. £49.95 ref SS66

THE TRUTH MACHINE Tells if someone is lying by micro tremors in their voice, battery operated, works in general conversation and on the 'phone and TV as well! £42.49 ref TD3

INFRA RED FILM 6" square piece of flexible infra red film that will only allow IR light through. Perfect for converting ordinary torches, lights, headlights etc to infra red output only using standard light bulbs Easily cut to shape. 6" square £15 ref IRF2

HYDROGEN FUEL CELL PLANS Loads of information on hydrogen storage and production. Practical plans to build a Hydrogen fuel cell (good workshop facilities required) £8 set ref FCP1

STIRLING ENGINE PLANS Interesting information pack covering all aspects of Stirling engines, pictures of home made engines made from an aerosol can running on a candle! £12 ref STIR2

ENERGY SAVER PLUGS Saves up to 15% electricity when used with fridges, motors up to 2A, light bulbs, soldering irons etc. £9 ea ref LOT71, 10 pack £69 ref LOT72.

12V OPERATED SMOKE BOMBS Type 3 is a 12v trigger and 3 smoke cannisters, each cannister will fill a room in a very short space of time! £14.99 ref SB3. Type 2 is 20 smaller cannisters (suitable for simulated equipment fires etc) and 1 trigger module for £29 ref SB2 Type 1 is a 12v trigger and 20 large cannisters £49 ref SB1

HI POWER ZENON VARIABLE STROBES Useful 12v PCB fitted with hi power strobe tube and control electronics and speed control potentiometer. Perfect for interesting projects etc 70x55mm 12vdc operation. £6 ea ref FLS1, pack of 10 £49 ref FLS2

NEW LASER POINTERS 4.5mw, 75 metre range, hand held unit runs on two AA batteries (supplied) 670nm. £29 ref DEC49J

HOW TO PRODUCE 35 BOTTLES OF WHISKY FROM A SACK OF POTATOES Comprehensive 270 page book covers all aspects of spirit production from everyday materials. Includes construction details of simple stills. £12 ref MS3

NEW HIGH POWER MINI BUG With a range of up to 800 metres and a 3 days use from a PP3 this is our top selling bug! less than 1" square and a 10m voice pickup range. £28 Ref LOT102.

IR LAMP KIT Suitable for cctv cameras, enables the camera to be used in total darkness! £6 ref EF138

INFRA RED POWERBEAM Handheld battery powered lamp, 4 inch reflector, gives out powerful pure infrared light! perfect for CCTV use, nightsights etc. £29 ref PB1.

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser , X K and KA bands, speed cameras, and all known speed detection systems. 360 degree coverage, front&rear waveguides, 1.1"x2.7"x4.6" fits on visor or dash £149

LOPTX Made by Samsung for colour TV £3 each ref SS52

LAPTOP LCD SCREENS 240x175mm, £12 ref SS51

WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA? We have collated 140 business manuals that give you information on setting up different businesses, you peruse these at your leisure using the text editor on your PC. Also included is the certificate enabling you to reproduce (and sell) the manuals as much as you like! £14 ref EP74

HIGH POWER DC MOTORS, PERMANENT MAGNET 12 - 24v operation, probably about 1/4 horse power, body measures 100m x 75mm with a 60mm x 5mm output shaft with a machined flat on it. Fixing is simple using the two threaded bolts protruding from the front. £22 ref MOT4

INFRA RED REMOTE CONTROLS made for TV's but may have other uses pack of 100 £39 ref IREM

Online web catalogue
bull-electrical.com

ELECTRONIC SPEED CONTROLLER KIT For the above motor is £19 ref MAG17. Save £5 if you buy them both together, 1 motor plus speed controller rrp is £41, offer price £36 ref MOT5A

SONY STEREO TV CHASSIS assemblies comprising complete TV PCB excluding tube and scan coils. Nicam stereo, mains input. Appear to be unused but sold 'as seen' Would probably be good for spares or as a nicam stereo TV sound receiver and amplifier. For KV29F1U and KV25F1U(BE3D) PCB no's 1-659-827-12 1-659-826-14 1-711-800-11 £20 ref STV1

RCB UNITS Inline IEC lead with fitted RC breaker. Installed in seconds.
Pack of 3 £9.98 ref LOT5A

RADIO CONTROLLED CARS etc No remotes but good strippers for servo's motors and receivers. Sold as is, no returns, mixed types. £3 each ref RCC2

VOICE CHANGERS Hold one of these units over your phone mouth piece an you can adjust your voice using the controls on the unit! Battery operated £15 ref CC3

LOW COST CORDLESS MIC 500' range, 90 - 105mhz, 115g, 193 x 26 x 39mm, 9v PP3 battery required. £17 ref MAG15P1

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. **£12.99** REF AUG10P3.

SOLAR POWER LAB SPECIAL 2x 6"x6" 6v 130mA cells, 4 LED's, wire, buzzer, switch + 1 relay or motor. **£7.99** REF SA27

SOLAR NICAD CHARGERS 4 x AA size £9.99 ref 6P476, 2 x C size £9.99 ref 6P477

5.25" FLOPPY DISKS, pack of 500 disks £25 ref FDj

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PROJECTS . . . THEORY . . . NEWS . . .
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VOL. 28 No. 3 **MARCH 1999**

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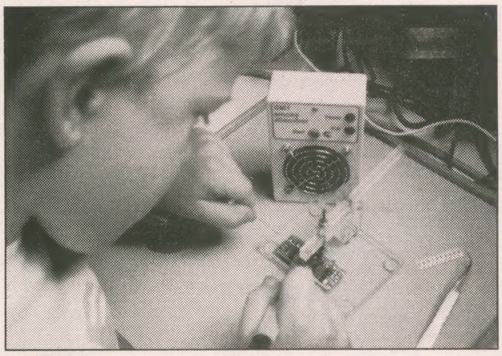

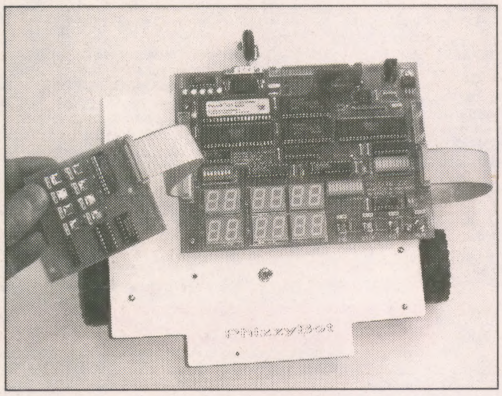

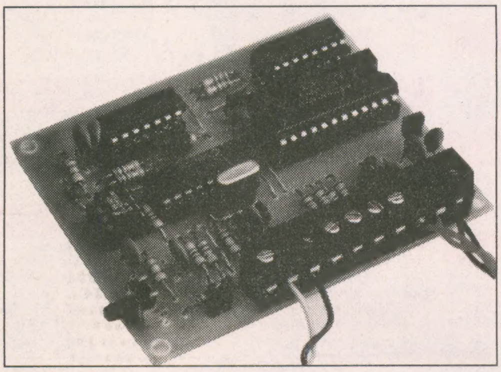

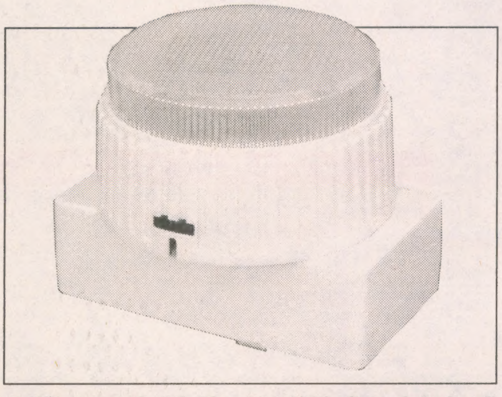

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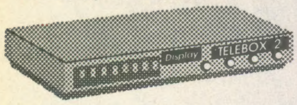

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TELEBOX ST for composite video input type monitors	**£36.95**
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For overseas PAL versions state 5.5 or 6 mHz sound specification.
*For cable / hyperband signal reception Telebox MB should be connected to a cable type service. Shipping on all Teleboxe's, code (B)

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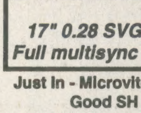

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Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors.
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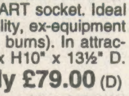
PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both **RGB and standard composite 15.625 Khz video inputs** via **SCART socket** and separate phono jacks. Integral audio **power amp and speaker** for **all audio visual uses.** Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security** applications with **direct connection to most colour cameras.** High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £99** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)



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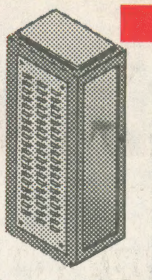

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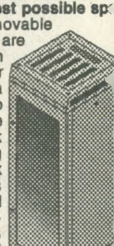

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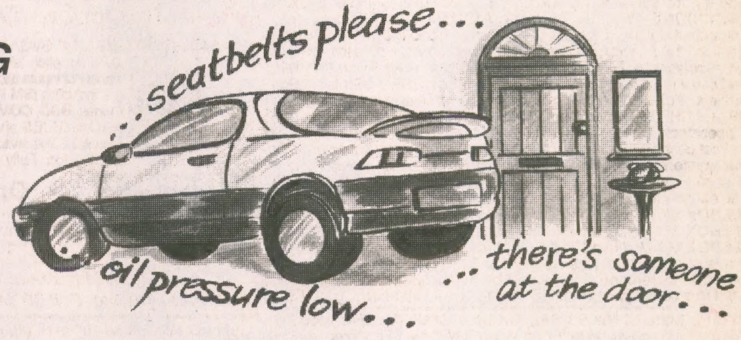
Alan's soldering section on the EPE *Web site has been referenced the world over – it is even used by one soldering iron manufacturer to add to their own information; this booklet has been developed from that material and should be equally highly regarded.*


...seatbelts please...
oil pressure low...
...there's someone at the door...

VERSATILE EVENT COUNTER

Prompted by a reader's telephone request for a unit to help him count musical beats, this constructional article first shows how a very simple BASIC program on a PC can do the job. It then takes the idea a lot further, presenting a self-contained PIC-microcontrolled design that will monitor the timing of all sorts of events. The results are displayed on an alphanumeric liquid crystal display.

Event signals can be input via a built-in microphone, via a jack-plugged connection to other electronic circuits, and via a panel mounted switch.

There are three monitoring modes:

- *Mode 1 displays the time elapsed since monitoring began; the elapsed time at which the last event was detected; the total events counted; the average rate at which the events have been occurring, selectable for counts per second, counts per minute and counts per hour.*
- *Mode 2 is a frequency counter, principally for monitoring an external electronically generated frequency of 0V/+5V amplitude, up to about 20kHz.*
- *Mode 3 counts the elapsed time between pairs of events and is of best use with events that are longer than about one second apart.*

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Inspired by the renowned Clockwork Radio invented by Trevor Baylis, this design shows a way in which a clockworkless power saving radio can be created using components more familiar to electronics enthusiasts than to mechanical buffs.

You still turn a handle, but it's not clockwork you wind up, it's a motor whose output voltage is stored in a really large capacity capacitor (one Farad, no less!). It's power from the capacitor that then keeps you tuned into the world via an easy-to-build direct conversion receiver, and the headphone-coupled output then stops you voluminously troubling the neighbours!

It's novel, it's simple, and it can give you lots of entertainment – not to mention the benefit of extra exercise!

PIC16F87x MICROCONTROLLERS REVIEW

Thousands of you have become familiar with the PIC family of microcontrollers, especially the PIC16x84 EEPROM versions. Arizona Microchip have now introduced a new range to the family, the PIC16F87x series. In many respects, these new devices can be regarded as greatly enhanced versions of the '84s.

Importantly, not only do they have greater capacity than the '84s, they offer more facilities that make them ideal candidates for use in many sophisticated designs for which the '84s could not readily provide complete control solutions.

Of particular importance are their several on-chip analogue-to-digital converters (ADCs), and their communications options based upon internal USART (universal synchronous asynchronous receiver transmitter) protocols.

This review takes an overall look at the capabilities of these much-welcomed new devices.

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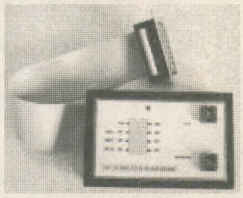

This integrated development environment offers a unique software development tool for the PIC 12C508 / 509. The package consists of 508/509 In-Circuit Emulator, Programmer, EdICE a fully integrated Assembler with trace functions & ICE508 tracer/disassembler.
The development system is supplied with MPASM assembler/disassembler and 10 projects, including circuit diagrams and unprotected source code. Projects cover subjects from simple sound effect generator through to an accurate Digital Volt Meter, Smoke Alarm, Stop Watch, LCD display driver, Keypad encoder and more
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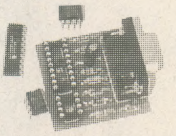
NEW! PIC PROGRAMMER KIT

Programs the Popular PIC 16C84, 16F84 and 24xx series serial memory devices. Connects to the serial port of a PC and requires No EXTERNAL power supply. The kit includes instructions for assembly, circuit diagram and component layout.



This handy little programmer is easy to build, taking no more than 30 mins. to assemble and test. The Professional quality PCB is double-sided, through-plated with solder resist and screen printing to aid efficient assembly. It is supplied with driver software to run in DOS on a 286 PC upwards and under Windows 95 on 486 or Pentium and a Disk full of interesting projects, tips and data sheets for PIC devices, including **FREE** Assembler and Simulator (requires 9-pin D-type to 9-pin D-type cable to connect to serial port of PC).
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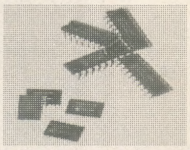

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Ando AC8211 – Spectrum Analyser 1.7GHz	£2250
Anritsu MS62B – 10KHz – 1700MHz	£2250
Anritsu MS341A + MS3401B – (10Hz – 30MHz)	£3995 + £4500
Anritsu MS610B – 10KHz – 2GHz – (Mint)	£4750
Anritsu MS710F – 100KHz – 23GHz Spectrum Analyser	£5950
Avcom PSA65 S – 1000MHz – portable.	£850
Hameg 8028/8038 – Spectrum Analyser/Tracking Gen +100MHz Oscilloscope	£1250
Hewlett Packard 182T with 8559A (10MHz – 21GHz)	£3750
Hewlett Packard 182T + 8558B – 0.1 to 1500MHz	£1750
Hewlett Packard 853A + 8558B – 0.1 to 1500MHz	£2500
Hewlett Packard 8591A – 9KHz – 1.8GHz with Option 10 Tracking Generator	£6500
Hewlett Packard 8594E – 9KHz – 2.9GHz	£7000
Hewlett Packard 35601A – Spectrum Analyser Interface	£1000
Hewlett Packard 3561A – Dynamic Signal Analyser	£4750
Hewlett Packard 3562A Dual Channel Dynamic Sig. Analyser	£6500
Hewlett Packard 3580A – 5Hz-50KHz	£995
Hewlett Packard 3582A – 0.02Hz – 25.6KHz (dual ch.)	£2000
Hewlett Packard 3585A – 20Hz – 40MHz	£4500
Hewlett Packard 8753A – Network Analyser	£4995
Hewlett Packard 8753B – Network Analyser	£6500
IFR 7750 10KHz – 1GHz	£2500
Marconi 2370 – 110MHz	£500
Marconi 2371 – 30KHz – 2000MHz	£750
Meguro MSA 4901 – 1-300GHz (AS NEW)	£850
Meguro MSA 4912 – 1-1GHz (AS NEW)	£1250
Rohde & Schwarz – SWOB 5 Polyskop 0.1 – 1300MHz	£1500
Takeda Riken 4132 – 1.0GHz Spectrum Analyser	£2500
Tektronix 7L18 with mainframe (1.5-60GHz with external mixers)	£2000
Tektronix 495P – 100Hz – 1.8GHz programmable	£4950
Tektronix 496P – 1KHz – 1.8GHz Spectrum Analyser	£4500

MISCELLANEOUS

Adret 740A – 100KHz – 1120MHz Synthesised Signal Generator	£800
Anritsu MG 360A Signal Generator 0.1-1040MHz	£1500
Anritsu ME 462B DF/3 Transmission Analyser	£2500
Anritsu MG 645B Signal Generator 0.05-1040MHz	£850
Boonton 92C R/F Millivoltmeter	£250
Boonton 93A True RMS Voltmeter	£250
Dranetz 626 – AC/DC – Multifunction Analyser	£600
EIP 331 – Frequency counter 18GHz	£600
EIP 545 – Frequency counter 18GHz	£1250
EIP 575 – Frequency counter 18GHz	£1450
Eltek SMPS – Power Supply 60v-30v	£400
ENI 550L – Power Amplifier (1.5-400MHz) 50W	£1500
Farnell TSV-70 MKII Power Supply (70V – 5A or 35V – 10A)	£250
Farnell DSG-1 Synthesised Signal Generator	£125
Farnell ESG-1000 Synthesised Signal Generator 1GHz (as new)	£995
Farnell AP 30250A Power Supply 3v - 250A	£1750
Feedback PFG 605 Power Function Generator	£200
Fluke 5100A – Calibrator	£2500
GN ELMI EPR31 PCM Signalling Recorder	£3000
Guildline 9152 – T12 Battery Standard Cell	£550
Hewlett Packard 1630D – Logic Analyser (43 Channels)	£650
Hewlett Packard 16500A – Fitted with 16510A/16515A/16530A/16531A – Logic Analyser	£4000
Hewlett Packard 331A – Distortion Analyser	£300
Hewlett Packard 333A – Distortion Analyser	£300
Hewlett Packard 334A – Distortion Analyser	£300
Hewlett Packard 3325A – 21MHz Synthesiser/Function Gen	£1500
Hewlett Packard 3336C – Synthesised Signal Generator (10Hz – 21MHz)	£1000
Hewlett Packard 3437A System voltmeter	£250
Hewlett Packard 3438A Digital multimeter	£200
Hewlett Packard 3455A 6½ Digit M/Meter (Autocal)	£600
Hewlett Packard 3456A Digital voltmeter	£600
Hewlett Packard 3488A – HP – 1B Switch control unit (various Plug-ins available)	£550
Hewlett Packard 3478A – Multimeter (5½ Digit) + HP – 1B	£550
Hewlett Packard 35600A Dual Ch. Dynamic Signal Analyser	£3750
Hewlett Packard 3586A – Selective Level Meter	£1000
Hewlett Packard 3711A/3712A/3791B/3793B Microwave Link Analyser	£2250
Hewlett Packard 3746A – Selective Measuring Set	£750
Hewlett Packard 3776A – PCM Terminal Test Set	£1500
Hewlett Packard 3779A/3779C – Primary Mux Analyser	from £600
Hewlett Packard 3784A – Digital Transmission Analyser	£5000
Hewlett Packard 3785A – Jitter Generator + Receiver	£1250
Hewlett Packard 37900D – Signalling Test Set (No 7 and ISDN)	£4250
Hewlett Packard P382A Variable Attenuator	£250
Hewlett Packard 4192A – LF Impedance Analyser	£7000
Hewlett Packard 4262A – Digital LCR Meter	£1250
Hewlett Packard 4279A – 1MHz C-V Meter	£4500
Hewlett Packard 4342A 'Q' Meter	£800
Hewlett Packard 435A or **B** Power Meter (with 8481A/8484A)	from £750
Hewlett Packard 4948A – (TIMS) Transmission impairment M/Set	£1500
Hewlett Packard 4972A – Lan Protocol Analyser	£1750
Hewlett Packard 5183 – Waveform Recorder	£1750
Hewlett Packard 5238A Frequency Counter 100MHz	£250
Hewlett Packard 5314A – (NEW) 100MHz Universal Counter	£250
Hewlett Packard 5316A – Universal Counter (IEEE)	£500
Hewlett Packard 5335A – 200MHz High Performance Systems Counter	£600
Hewlett Packard 5370B – Universal Timer/Counter	£2000
Hewlett Packard 5384A – 225 MHz Frequency Counter	£650
Hewlett Packard 5385A Frequency Counter – 1GHz – (HP1B) with OPTS 001/003/004/005	£995
Hewlett Packard 5420A Digital Signal Analyser	£350
Hewlett Packard 6033A Power Supply Autoranging (20V – 30A)	£750
Hewlett Packard 6253A Power Supply 20V – 3A Twin	£200
Hewlett Packard 6255A Power supply 40V – 1.5A Twin	£200

HEWLETT PACKARD 6261B
Power Supply 20V-50A £450 *Discount for Quantities*

Hewlett Packard 6264B – Power Supply (0 – 20V, 0 – 25A)	£400
Hewlett Packard 6266B Power Supply 40V – 5A	£220
Hewlett Packard 6271B Power supply 60V – 3A	£225
Hewlett Packard 6632A – Power Supply (20V – 5A)	£800
Hewlett Packard 7475A – 6 Pen Plotter	£250
Hewlett Packard 7550A – 8 Pen Plotter A3/A4	£450
Hewlett Packard 8015A – 50MHz Pulse Generator	£750
Hewlett Packard 8152A – Optical Average Power Meter	£1250
Hewlett Packard 8158B – Optical Attenuator (OPTS 002 + 011)	£1100
Hewlett Packard 8165A – 50MHz Programmable Signal Source	£1650
Hewlett Packard 8180A – Data Generator	£1500
Hewlett Packard 8182A – Data Analyser	£1500
Hewlett Packard 8350B – Sweep Oscillator Mainframe (various plug-in options available)	£2500
Hewlett Packard 83554A – Wave Source Module 26.5 to 40GHz	£3500
Hewlett Packard 83555A – Millimeter – Wave source Module 33-50GHz	£4250
Hewlett Packard 8405A – Vector Voltmeter	£350
Hewlett Packard 8620C Sweep oscillator mainframe	from £250
Hewlett Packard 8640B – Signal Generator (512MHz + 1024MHz)	from £850
Hewlett Packard 8656A – Synthesised Signal Generator (990MHz)	£1250
Hewlett Packard 8656B – Synthesised Signal Generator	£1750
Hewlett Packard 8657A – Signal Generator (100KHz-1040MHz)	£2500
Hewlett Packard 8660D – Synthesised Signal Generator (10KHz-2600MHz)	£3250
Hewlett Packard 8750A Storage normaliser	£375
Hewlett Packard 8756A – Scalar Network Analyser	£1500
Hewlett Packard 8757A – Scalar Network Analyser	£2250
Hewlett Packard 8901A – Modulation Analyser	£2750
Hewlett Packard 8901B – Modulation Analyser	£3750
Hewlett Packard 8903A – Audio Analyser (20Hz – 100KHz)	£1600
Hewlett Packard 8903B – Distortion Analyser	£2500
Hewlett Packard 8903E – Distortion Analyser (Mint)	£2000
Hewlett Packard 8920A – R/F Comms Test Set	£4995
Hewlett Packard 8922b – GSM Radio Comms Test Set	£8500
Hewlett Packard 8958A – Cellular Radio Interface	£2000
Keytek MZ-15/EC Minizap 15Kv Hand Held ESD Simulator	£1750
Krohn-Hite 2200 Lin/Log Sweep Generator	£995
Krohn-Hite 4024A Oscillator	£250
Krohn-Hite 5200 Sweep, Function Generator	£350
Krohn-Hite 6500 Phase Meter	£250
Leader LDM-170 – Distortion Meter	£350
Leader 3216 – Signal Generator (100KHz – 140KH`z) AM/FM/CW with built-in FM stereo modulator (mint)	£995
Marconi 2019 – 80KHz – 1040MHz Synthesised Sig. Gen	£950
Marconi 2019A – 80KHz – 1040MHz – Synthesised Signal Generator	£1250
Marconi 2305 – Modulation Meter	£1995
Marconi 2337A – Automatic Distortion Meter	£150
Marconi 2610 – True RMS Voltmeter	£850
Marconi 2871 Data Comms Analyser	£1000
Marconi 2955 – Radio Comms Test Set	£2250
Marconi 6960 – Power Meter & Sensor	from £950
Philips PM 5167MHz function gen	£400
Philips 5190 L.F. Synthesiser (G.P.I.B)	£800
Philips 5193 Synthesised Function Generator	£1500
Philips 5518 Synthesised Function Generator	£1500
Philips PM5519 – TV Pattern Generator	£350
Philips PM5716 – 50MHz Pulse Generator	£525
Prema 4000 – 6 ½ Digit Multimeter (NEW)	£450
Quartzlock 2A – Off Air Frequency Standard	£200
Racal 1992 – 1.3GHz Frequency Counter	£800
Racal 6111/6151 – GSM Radio Comms Test Set	£POA
Racal Dana 9081/9082 Synth. sig. gen. 520MHz	from £500
Racal Dana 9084 Synth. sig. gen. 104MHz	£450
Racal 9301A – True RMS R/F Multivoltmeter	£300
Racal Dana 9302A R/F multivoltmeter (new version)	£375
Racal Dana 9303 R/F Level Meter & Head	£650
Racal Dana 9917 UHF frequency meter 560MHz	£175
Rohde & Schwarz LFM2 – 60MHz Group Delay Sweep Gen	£1600
Rohde & Schwarz Scud Radio Code Test Set	£300
Rohde & Schwarz CMTA 94 GSM Radio Comms Analyser	£7500
Schaffner NSG 203A Line Voltage Variation Simulator	£950
Schaffner NSG 222A Interference Simulator	£850
Schaffner NSG 223 Interference Generator	£850
Schlumberger 2720 1250MHz Frequency Counter	£500
Schlumberger 4031 – 1GHz Radio Comms Test Set	£4995
Schlumberger Stabilock 4040 Radio Comms Test Set	£2995
Schlumberger 7060/7065/7075 Multimeters	from £350
Solartron 1250 – Freq. Response Analyser	£2500
Stanford Research DS 340 – 15MHz Synthesised Function (NEW) and arbitrary waveform generator	£1200
Systron Donner 6030 – Microwave Frequency Counter (26.5GHz)	£2500
Telequipment CT71 Curve Tracer	£250
Tektronix AM503 + TM501 + P6302 – Current Probe Amplifier	£995
Tektronix PG506 + TG501 + SG503 + TM503 – Oscilloscope Calibrator	£1995
Tektronix 577 – Curve Tracer	£1150
Tektronix 1240 Logic Analyser	£500
Tektronix 141A PAL Test Signal Generator	£250
Tektronix AA5001 & TM5006 M/F – Programmable Distortion Analyser	£1995
Tektronix TM5003 + AFG 5101 Arbitrary Function Gen.	£1500
Tektronix DAS9100 – Series Logic Analyser	£500
Tektronix – Plug-ins – many available such as SC504, SW503, SG502, PG508, FG504, FG503, TG501, TR503 + many more	£POA
Time 9811 Programmable Resistance	£400
Time 9814 Voltage Calibrator	£550
Valhalla Scientific – 2724 Programmable Resistance Standard	£P.O.A.
Wandel & Goltermann PFJ-8 – Error/Jitter Test Set	£12500
Wandel & Goltermann PCM4 (+ options)	£9950
Wandel & Goltermann MU30 Test Point Scanner	£2000
Wayne Kerr 4225 – LCR Bridge	£600
Wavetek 171 – Synthetised Function Generator	£250
Wavetek 172B Programmable Sig Source (0.0001Hz – 13MHz)	£P.O.A.
Wavetek 184 – Sweep Generator – 5MHz	£250
Wavetek 3010 – 1-1GHz Signal Generator	£1250
Wiltron 6409 – RF Analysers (1MHz – 2GHz)	£POA
Wiltron 6620S – Programmable Sweep Generator (3.6 – 6.5GMz)	£650
Wiltron 6747-20 – Swept Frequency Synthesiser (10MHz-20GHz)	£4950
Yokogowa 3655 – Analysing Recorder	£POA

MANY MORE ITEMS AVAILABLE -
SEND LARGE S.A.E. FOR LIST OF EQUIPMENT
ALL EQUIPMENT IS USED -
WITH 30 DAYS GUARANTEE.
PLEASE CHECK FOR AVAILABILITY BEFORE
ORDERING – CARRIAGE & VAT TO BE ADDED
TO ALL GOODS

£1 BARGAIN PACKS – List 1

1,000 items appear in our Bargain Packs List – request one of these when you next order.

2 LITHIUM COIN CELLS, 3V p.c.b. mounting, Order Ref: 1078.

2×5A BRIDGE RECTIFIERS with heatsink couplers for 12V charger, Order Ref: 1070.

1×12V STEPPER MOTOR, 7·5 degrees. Order Ref: 910.

1×10 PACK SCREWDRIVERS. Order Ref: 909.

2×AMP PULL CORD CEILING SWITCHES, brown. Order Ref: 921.

5×REELS INSULATION TAPE. Order Ref: 911.

2×CORD GRIP SWITCH LAMP HOLDERS. Order Ref: 913.

1×DC VOLTAGE REDUCER, 12V-6V. Order Ref: 916.

LIGHTWEIGHT STEREO HEADPHONES, moving coil so superior sound. Order Ref: 896.

2×25W CROSSOVERS for 4ohm loudspeakers. Order Ref: 22.

2×Nicad CONSTANT CURRENT CHARGERS, easily adaptable to charge almost any NiCad Battery. Order Ref: 30.

18V-0-18V 10VA mains transformer. Order Ref: 813.

2×WHITE PLASTIC BOXES with lids, approx. 3in. cube. Lid has square hole through the centre so these are ideal for light-operated switch. Order Ref: 132.

2×REED RELAY KITS, you get 8 reed switches and 2 coil sets. Order Ref: 148.

12V-0-12V 6VA mains transformer, p.c.b. mounting. Order Ref: 938.

1×BIG-PULL SOLENOID, mains operated, has ½in. pull. Order Ref: 871.

1×BIG-PUSH SOLENOID, mains operated, has ½in. push. Order Ref: 872.

1×MINI MONO AMP. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.

1×MINI STEREO 1W AMP. Order Ref: 870.

15V DC 150mA P.S.U., nicely cased. Order Ref: 942.

1×IN-FLIGHT STEREO UNIT is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC pasengers. Order Ref: 29.

1×0-1mA PANEL METER. Full vision face 70mm square. Scaled 0-100. Order Ref: 756.

2×LITHIUM BATTERIES. 2·5V penlight size. Order Ref: 874.

2x3m TELEPHONE LEADS. With BT flat plug. Ideal for 'phone extensions, fax, etc. Order Ref: 552.

1×12V SOLENOID. Has good ½in. pull or could push if modified. Order Ref: 232.

3×IN-FLEX SWITCHES. With neon on/off lights, saves leaving things switched on. Order Ref: 7.

2×6V 1A MAINS TRANSFORMERS. Upright mounting with fixing clamps. Order Ref: 9.

1×HUMIDITY SWITCHES. As the air becomes damper, the membrane stretches and operates a microswitch. Order Ref: 32.

4×13A ROCKER SWITCH. Three tags so on/off, or changeover with centre off. Order Ref: 42.

1×SUCK OR BLOW-OPERATED PRESSURE SWITCH. Or it can be operated by any low pressure variation, such as water level in tanks. Order Ref: 67.

1×6V 750mA POWER SUPPLY. Nicely cased with mains input and 6V output lead. Order Ref: 103A.

12 VERY FINE DRILLS. For p.c.b. boards etc. Normal cost about 80p each. Order Ref: 128.

5×MOTORS FOR MODEL AEROPLANES. Spin to start so needs no switch. Order Ref: 134.

6×MICROPHONE INSERTS. Magnetic 400 ohm, also act as speakers. Order Ref: 139.

6×NEON INDICATORS. In panel mounting holders with lens. Order Ref: 180.

1×IN-FLEX SIMMERSTAT. Keeps your soldering iron etc. always at the ready. Order Ref: 196.

1×ELECTRIC CLOCK. Mains operated. Put this in a box and you need never be late. Order Ref: 211.

4×12V ALARMS. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221.

2×(6in.×4in.) SPEAKERS. 16 ohm 5 watts, so can be joined in parallel to make a high wattage column. Order Ref: 243.

1×PANOSTAT. Controls output of boiling ring from simmer up to boil. Order Ref: 252.

2×OBLONG PUSHSWITCHES. For bell or chimes, these can switch mains up to 5A so could be footswitch if fitted in pattress. Order Ref: 263.

50×MIXED SILICON DIODES. Order Ref: 293.

1×6 DIGIT MAINS OPERATED COUNTER. Standard size but counts in even numbers. Order Ref: 28.

2×6V OPERATED REED RELAYS. One normally on, other normally closed. Order Ref: 48.

1× CABINET LOCK. With two keys. Order Ref: 55.

6½ 8Ω 5 WATT SPEAKER. Order Ref: 824.

1× SHADED POLE MAINS MOTOR. ¾in. stack, so quite powerful. Order Ref: 85.

1×CASE, 3½×2¼×1¾ with 13A socket pins. Order Ref: 845.

2×CASES. 2½×2¼×1¾ with 13A pins. Order Ref: 565.

4×LUMINOUS ROCKER SWITCHES. 10A mains. Order Ref: 793.

BATTERY MOTOR WITH GEARBOX. Will operate on any DC voltage between 6V and 24V, price £3. Order Ref: 3P108. A speed controller is available for this, £12 in kit form or £20 made up, but if you intend to operate it from the mains, then our power supply 2P3 will give you 3 speeds and will also reverse. Price of power supply is £2.

A MUCH LARGER PROJECT BOX. Size 216mm×130mm×85mm with lid and 4 screws. This is an ABS box which normally retails at around £6. All brand new, price £2.50. Order Ref: 2.5P28.

BT TELEPHONE EXTENSION WIRE. This is proper heavy duty cable for running around the skirting board when you want to make a permanent extension. Four cores properly colour coded, 25m length only £1. Order Ref: 1067.

LARGE TYPE MICROSWITCH. With 2in. lever, changeover contacts rated at 15A at 250V, 2 for £1. Order Ref: 1/21R7.

MINI MICROSWITCH. Only approximately 15mm long with a 20mm lever which could quite easily be removed, changeover contacts rated at 5A AC, 50p each. Order Ref: 1/21R8.

FLEX PROTECTORS. Rubber, 30mm long, 8mm diameter with a 12mm shoulder. Ideal for protecting flex passing through a metal panel, 5 for £1. Order Ref: 1/21R10.

10K POT. With double-pole mains on/off switch, good length of ¼in. spindle and hex fixing nut, 50p each. Order Ref: 1/22R6.

DITTO but 5K. Order Ref: 1/11R24.

BALANCE ASSEMBLY KITS. Japanese made, when assembled ideal for chemical experiments, complete with tweezers and 6 weights 0·5 to 5 grams. Price £2. Order Ref: 2P444.

SUPER CROMPTON PARKINSON MAINS MOTOR. Really well made, totally enclosed by ventilated framework. Size approximately 4in. diameter, 4in. high and with 2in. of a ⅜in. spindle. Speed is 750rpm, hp is not quoted but we estimate this to be around 1/6hp. Price £10. Order Ref: 10P149.

EQUIPMENT COOLING BLOWER. Near enough 5in. square and 1½in. thick but a really good air mover. Mains operated, price £4. Order Ref: 715L.

OVEN THERMOSTAT with knob calibrated so you can set it to cut out at any temperature up to 600°F, £3. Order Ref: 3P229.

DOORBELL PSU. This has A.C. voltage output so is ideal for operating most doorbells. The unit is totally enclosed so perfectly safe and it plugs into a 13A socket. Price only £1. Order Ref: 1/30R1.

THIS MONTH'S TWO FOR ONE OFFER IS THE POWER SUPPLY

Made by Astec, outputs are 12V at 4A and 5V at 15A. This PSU can be modified with a few extra components and would then give 12V at 10A d.c. We give the details. The price is still £9.50 but you get two instead of one.
Offer ends 31st March, Order Ref: 9.5P4.

GEAR WHEELS. Set of 5, quite small, should enable you to get a variety of speeds, mounted in a metal case but easy to remove and use separately. Price £1 the set. Order Ref: D409.

ULTRASONIC MOVEMENT DETECTOR. Nicely cased, free standing, has internal alarm which can be silenced. Also has connections for external speaker or light. Price £10. Order Ref: 10P154.

CYCLE LAMP BARGAIN. You can have 100 6V 0·5A MES bulbs for just £2.50 or 1,000 for £20. They are beautifully made, slightly larger than the standard 6·3V pilot bulb so they would be ideal for making displays for night lights and similar applications. 50 joined in series can be connected to the mains and would make a very attractive window display. 100 for £2.50. Order Ref: 2.5P29.

12Vx12V RELAY. Miniature, clear platic enclosed, has one set changeover contacts, one set that breaks contact and 3 sets that make contact. Price £1 each. Order Ref: GR30.

COMPONENT MOUNTING PANEL. Heavy Paxolin, size approximately 10in.×2in. with 32 pairs of brass pillars for soldering or binding on components, £1. Order Ref: 1/7RC26.

AIR-SPACED TUNING CAPACITOR. Twin 100pF with trimmers, extra small. Fixed from the front by 3 screws, £2 each. Order Ref: 1/7RC29.

PEA LAMPS. Very tiny, only 4mm, but 14V at 0·04A, wire-ended, 25p each. Order Ref: 1/7RC28.

HIGH AMP THYRISTOR. Normal two contacts from the top and heavy threaded fixing underneath. We don't know the amperage of this but think it to be at least 25A. Price 50p each. Order Ref: 1/7RC43.

THREE LEVEL PRESSURE SWITCH. All 3 are low pressures and the switch could be blow-operated. With a suitable tubing these switches could control the level of liquid, etc., price £1. Order Ref: 67.

FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a Xenon tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price £5. Order Ref: 5P267.

LIGHT ALARM. Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery, £3. Order Ref: 3P155.

WATER LEVEL ALARM. Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the preset level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, £3. Order Ref: 3P156.

BIKE RADIO. In fact, it's more than a radio, it's an alarm and a spotlight. The radio is battery operated, of course, and needs 3 AA cells. Only one band but this is the FM band so will receive Radio 1 and 2. Comes complete with handlebar fixing clips. Price £4. Order Ref: 4P72.

EMERGENCY LIGHTING UNIT with perspex cover. Contains internal rechargeable batteries and its own charger to operate an internal fluorescent tube. Stays on for 3 hours should mains fail. Price £15. Order Ref: 15P32.

PHILIPS 9in. MONITOR. Not cased, but it is in a frame for rack mounting. It is high resolution and was made to work with the IBM 'One per disk' computer. Price £15. Order Ref: 15P1.

METAL CASE FOR 9in. MONITOR. Supplied as a flat pack, price £12. Order Ref: 12P3.

TELEPHONE EXTENSION LEAD. Nicely made and BT approved. Has the plug into BT socket one end and the telephone socket the other end, total length 12m, £2. Order Ref: 2P338.

INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges, AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. Ex-British Telecom but in very good condition, tested and guaranteed, probably cost at least £50 each, yours for only £7.50 with leads, carrying case £2 extra. Order Ref: 7.5P4.

REPAIRABLE METERS. We have some of the above testers but faulty, not working on all ranges, should be repairable, we supply diagram, £3. Order Ref: 3P176.

PIANO ON KEY CHAIN. Although it is quite small, only 20mm long, it will play any tune. Instructions with it tell you which keys to press for 'Happy Birthday', 'Twinkle Twinkle Little Star', 'Jingle Bells' and 'London Bridge'. It is also a light, it has a little lamp which can be operated by the end switch. Battery operated (not included), price £1.50. Order Ref: 1.5P39.

12V RECHARGEABLE YUASA BATTERY. Sealed so usable in any position – suit golf trolley, lawn mower, portable lights, etc., etc., only £3.50. Order Ref: 3.5P11.

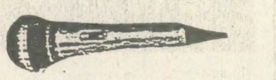
CHARGER FOR YUASA BATTERY. This battery charger plugs into a 13A socket, charges at approximately 1/2A so it would charge this battery overnight. Complete with croc clips, ready to go, £5. Order Ref: 5P269.

8mm PROJECTORS. With zoom lens, brand new and perfect, complete with one reel and handbook. Regular price over £100, yours for £39. Order Ref: 39P1.

Ditto but with sound as well and a mike, £49. Order Ref: 49P1. The zoom lens alone is worth more.

SOLDERING IRON. Super mains powered with long life ceramic element, heavy duty 40W for the extra special job. Complete with plated wire stand and 245mm lead, £3. Order Ref: 3P221.

DYNAMIC MICROPHONE. 500 ohm, plastic body with black mesh head, on/off switch, good length lead and terminated with audio plug, £2. Order Ref: 2P220.



1/10th HORSEPOWER 12V MOTOR. Made by Smiths, the body length of this is approximately 3in., the diameter 3in. and the spindle 5/16in. diameter. Quite a powerful little motor which revs at 2000rpm. Price £6. Order Ref: 6P47.

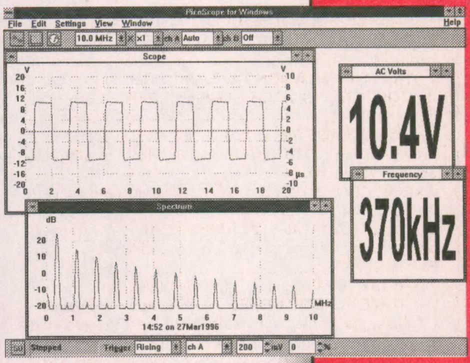
MINI BLOW HEATER. 1kW, ideal for under desk or airing cupboard, etc. Needs only a simple mounting frame, price £5. Order Ref: 5P23.

TERMS

Send cash, PO, cheque or quote credit card number – orders under £25 add £3.50 service charge.

J & N FACTORS
Pilgrim Works (Dept. E.E.)
Stairbridge Lane, Bolney,
Sussex RH17 5PA
Telephone: 01444 881965

Transform your PC.... Into an oscilloscope, spectrum analyser and multimeter...



The ADC-200 range of PC based oscilloscopes offer performance only previously available on the most expensive `benchtop' scopes. By intergrating several instruments into one unit, the ADC-200 is both flexible and cost effective.

Connection to a PC gives the ADC-200 the edge over traditional oscilloscopes: the ability to print and save waveforms is just one example. Units are supplied with PicoScope for Windows which is powerful, yet simple to use, with comprehensive on line help.

Applications

- ▼ Video
- ▼ Automotive
- ▼ Electronics design
- ▼ Production line tests
- ▼ Fault finding
- ▼ Education

All units are supplied with software, cables and power supply. Prices exclude VAT.

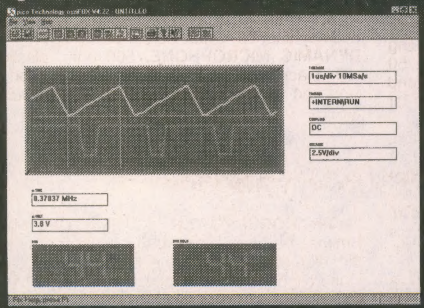
Features

- ▼ A fraction of the cost of comparable benchtop oscilloscopes
- ▼ Up to 100 MS/s sampling
- ▼ Advanced tigger modes- capture one off events.
- ▼ Up to 50 MHz spectrum analyser
- ▼ Large buffer memory

ADC-200/100	£499
ADC-200/50	£399
ADC-200/20	£299

A scope at your fingertips.....

Once oscilloscopes were heavy and clumsy to handle, but over the years they have become smaller and smaller. The latest development in this field has just arrived: a digital storage oscilloscope in a handy slim housing, scarcely longer than a pencil and about as thick as your thumb. Despite its small size, its performance can match that of a service oscilloscope.



ONLY £80

Applications

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- ▼ Hobby electronics
- ▼ Measurements in amplifiers
- ▼ Production line tests

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- ▼ Sample rates from 50ns to 1ms
- ▼ Up to 20 MS/s

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EPE MICROCONTROLLER P.I. TREASURE HUNTER

The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

- ● New circuit design 1994
- ● High stability drift cancelling
- ● Easy to build & use
- ● No ground effect, works in seawater
- ● Detects gold, silver, ferrous & non-ferrous metals
- ● Efficient quartz controlled microcontroller pulse generation.
- ● Full kit with headphones & all hardware

KIT 847......................£63.95

PORTABLE ULTRASONIC PEsT SCARER

A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

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KIT 865........................£29.95

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Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1·5 to 4·5V Multi ratio gearbox gives wide range of speeds.

LARGE TYPE – MGL £6.95
SMALL – MGS – £4.77

Stepping Motors

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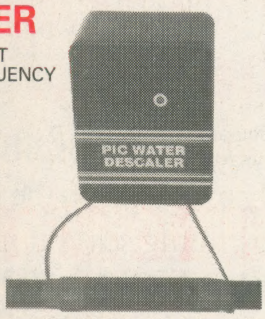
MD200...200 step...£12.99
MD24...Large 200 step...£22.95

PIC PIPE DESCALER

- ● SIMPLE TO BUILD
- ● SWEPT FREQUENCY
- ● HIGH POWER OUTPUT
- ● AUDIO & VISUAL MONITORING

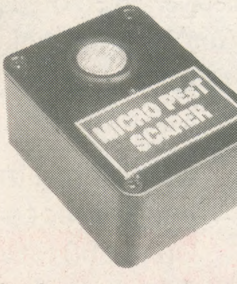
An affordable circuit which sweeps the incoming water supply with variable frequency electromagnetic signals. May reduce scale formation, dissolve existing scale and improve lathering ability by altering the way salts in the water behave.
Kit includes case, P.C.B, coupling coil and all components.
High coil current ensures maximum effect. L.E.D. monitor



KIT 868 ....£22.95 POWER UNIT.........£3.99

MICRO PEsT SCARER

Our latest design – The ultimate scarer for the garden. Uses special microchip to give random delay and pulse time. Easy to build reliable circuit. Keeps pets/pests away from newly sown areas, play areas, etc. Uses power source from 9 to 24 volts.



- **● RANDOM PULSES**
- **● HIGH POWER**
- **● DUAL OPTION**

Plug-in power supply £4.99

KIT 867...................................£19.99
KIT+ SLAVE UNIT..................£32.50

WINDICATOR

A novel wind speed indicator with LED readout. Kit comes complete with sensor cups, and weatherproof sensing head. Mains power unit £5.99 extra.

KIT 856..£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes **£6.50**

Magenta have prepared a FULL KIT for this excellent new project. All components, PCB, hardware and electrodes are included. Designed for simple assembly and testing and providing high level dual output drive.

KIT 866.... Full kit including four electrodes £32.90

1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.
Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848..................£32.95

SPACEWRITER

NOW WITH PIC16C84 EEPROM CHIP & SOFTWARE DISK

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube plus instructions for message loading.

KIT 849.......................£16.99

12V EPROM ERASER

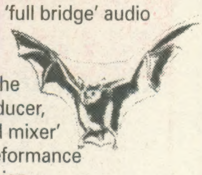
A safe low cost eraser for up to 4 EPROMS at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work – updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

KIT 790...........................£28.51

SUPER BAT DETECTOR

NEW!

1 WATT O/P, BUILT IN SPEAKER, COMPACT CASE
20kHz-140kHz
NEW DESIGN WITH 40kHz MIC.



A new circuit using a 'full bridge' audio amplifier i.c., internal speaker, *and* headphone/tape socket. The latest sensitive transducer, and 'double balanced mixer' give a stable, high peformance superheterodyne design.

KIT 861.......................£24.99
ALSO AVAILABLE Built & Tested £39.99

E.E. TREASURE HUNTER P.I. METAL DETECTOR MKI

Magenta's highly developed & acclaimed design. Quartz crystal controlled circuit MOSFET coil drive. D.C. coupled amplification. Full kit includes PCB, handle, case & search coil.

- ● KIT INC. HEADPHONES
- ● EFFICIENT CMOS DESIGN
- ● POWERFUL COIL DRIVE
- ● DETECTS FERROUS AND NON-FERROUS METAL – GOLD, SILVER, COPPER ETC.
- ● 190mm SEARCH COIL
- ● NO 'GROUND EFFECT'

KIT 815..........................£45.95

MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2·5A.

Based on our Mk1 design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 *EPE*. An essential piece of equipment.

Kit No. 845................£64.95

EPE PROJECT PICs

NOW £5.90

Programmed PICs for all* EPE Projects
Now one price
£5.90 each

(*some projects are copyright)

ULTRASONIC PEsT SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

- ● KIT INCLUDES ALL COMPONENTS, PCB & CASE
- ● EFFICIENT 100V TRANSDUCER OUTPUT
- ● COMPLETELY INAUDIBLE TO HUMANS
- ● UP TO 4 METRES RANGE
- ● LOW CURRENT DRAIN

KIT 812...£14.81

SIMPLE PIC PROGRAMMER

INCREDIBLE LOW **PRICE!**

Kit 857 **£12.99**

INCLUDES 1-PIC16F84 CHIP SOFTWARE DISK, LEAD CONNECTOR, PROFESSIONAL PC BOARD & INSTRUCTIONS

Power Supply £3.99

EXTRA CHIPS: PIC 16F84 £4.84

Based on the design in February '96 *EPE* article, Magenta have made a proper PCB and kit for this project. PCB has 'reset' switch, Program switch, 5V regulator and test L.E.D.s. There are also extra connection points for access to all A and B port pins.

PIC16C84 LCD DISPLAY DRIVER

INCLUDES 1-PIC16F84 WITH DEMO PROGRAM SOFTWARE DISK, PCB, INSTRUCTIONS AND 24-CHARACTER 2-LINE **LCD DISPLAY**

Kit 860 **£19.99**

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

Another super PIC project from Magenta. Supplied with PCB, industry standard 2-LINE x 16-character display, data, all components, and software to include in your own programs. Ideal develpment base for meters, terminals, calculators, counters, timers – Just waiting for your application!

★ Chip is pre-programmed with demo display ★

PIC16C84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- WITH PROGRAMMED 16F84 AND DISK WITH SOURCE CODE IN MPASM
- ZERO VOLT SWITCHING – 10 CHASE PATTERNS
- OPTO ISOLATED
- 4 X 3 KEYPAD CONTROL
- SPEED CONTROL POT.
- HARD FIRED TRIACS
- 4 CHANNELS @5 AMPS

Now features full 4-channel chaser software on DISK and pre-programmed PIC16F84 chip. Easily re-programmed for your own applications. Software source code is fully 'commented' so that it can be followed easily.

Kit 855 **£39.95**

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ALL PARTS FOR SERIES INCLUDING PCBs, PROGRAMMED CHIP, CD-ROM AND DISPLAYS

MAIN BOARD – FULL KIT ... **£131.95** BUILT ... **£149.95**

I/O PORT ....KIT **£16.99** BUILT **£24.99**

L.C.D. ....**£12.49** POWER SUPPLY **£3.99**

8-BIT SWITCH/LATCH .....**£7.95** INT. MODULE **£10.45**

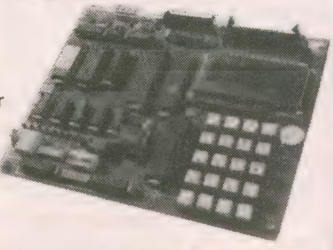
68000 DEVELOPMENT AND TRAINING KIT

KIT 621 **£99.95**

8 MHz 68000 16-BIT BUS
MANUAL AND SOFTWARE
2 SERIAL PORTS, PIT,
AND I/O PORTS

PSU £6.99
SERIAL LEAD £3.99

Mini-Lab & Micro Lab Electronics Teach-In 7



As featured in *EPE* and now published as Teach-In 7. All parts are supplied by Magenta. *Teach-In 7* is £3.95 from us or *EPE*

Full Mini Lab Kit – £119.95 –
Power supply extra – £22.55
Full Micro Lab Kit – £155.95
Built Micro Lab – £189.95

EPE PIC Tutorial

NEW!

At Last! A Real, Practical, Hands-On Series
3-Part Series – Starting March '98

- **Learn Programming from scratch**
- **Uses Re-Programmable PIC16F84 Chip**
- **Start by lighting an l.e.d. and work up through over 30 tutorials to Sound Generation, Data Display, and a Security System**
- **PIC TUTOR Board has Input Switches, Output l.e.d.s, and on board programmer**

PIC TUTOR BOARD KIT

Includes: PIC16F84 Chip, TOP Quality PCB printed with Component Layout and all components* (*not ZIF Socket or Displays). Included with the Magenta Kit is a disk with Test and Demonstration routines.

KIT 870 ...... £27.95, Built & Tested £42.95

Optional: **Power Supply – £3.99, ZIF Socket – £9.99**

LCD Display – With Software and Connection details **£7.99**

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PIC TOOLKIT

NEW!

- PROGRAMS PIC16C84 and 16F84
- ACCEPTS TASM AND MPASM CODE

Full kit includes PIC16F84 chip, top quality p.c.b. printed with component layout, turned pin PIC socket, all components and software*
*Needs QBASIC or QUICKBASIC

KIT 871 . . . £13.99. Built and tested **£21.99**

SUPER PIC PROGRAMMER

- READS, PROGRAMS, AND VERIFIES
- WINDOWS™ SOFTWARE
- PIC16C6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
- USES STANDARD MICROCHIP • HEX FILES
- OPTIONAL DISASSEMBLER SOFTWARE (EXTRA)
- PCB, LEAD, ALL COMPONENTS, TURNED PIN SOCKETS FOR 18, 28, AND 40 PIN ICs.

- SEND FOR DETAILED INFORMATION – A SUPERB PRODUCT AT AN UNBEATABLE LOW PRICE.

Kit 862 **£29.99**

Power Supply £3.99

DISASSEMBLER SOFTWARE **£11.75**

PIC STEPPING MOTOR DRIVER

INCLUDES: PCB, PIC16F84 WITH DEMO PROGRAM, SOFTWARE DISK, INSTRUCTIONS AND MOTOR.

Kit 863 **£18.99**

FULL SOURCE CODE SUPPLIED. ALSO USE FOR DRIVING OTHER POWER DEVICES e.g. SOLENOIDS.

Another NEW Magenta PIC project. Drives any 4-phase unipolar motor – up to 24V and 1A. Kit includes all components and 48 step motor. Chip is pre-programmed with demo software, then write your own, and re-program the same chip! Circuit accepts inputs from switches etc and drives motor in response. Also runs standard demo sequence from memory.

MAGENTA

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See Next / Last Months Ad. for COMPONENT ACCESSORIES

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8 Pin DIL 0.3"	£0.06
14 Pin DIL 0.3"	£0.11
16 Pin DIL 0.3"	£0.11
18 Pin DIL 0.3"	£0.12
20 Pin DIL 0.3"	£0.11
24 Pin DIL 0.6"	£0.13
28 Pin DIL 0.6"	£0.13
40 Pin DIL 0.6"	£0.19

Turned Pin

8 Pin DIL 0.3"	£0.11
14 Pin DIL 0.3"	£0.20
16 Pin DIL 0.3"	£0.23
18 Pin DIL 0.3"	£0.25
20 Pin DIL 0.3"	£0.28
24 Pin DIL 0.6"	£0.35
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1 x 36 Way Straight	£0.38
2 x 36 Way Straight	£0.56
1 x 36 Way 90°	£0.54
2 x 36 Way 90°	£0.80

Available in 2,3,4,5 & 10 way. Also female PCB sockets & jumper links.

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16 Way Socket	£0.31
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50 Way Straight	£0.96
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20 Way 90°	£0.53
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D Type Connectors

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9 Way Male Plug	£0.29
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15 Way H.D. Socket	£0.78
23 Way Male Plug	£0.49
23 Way Female Socket	£0.49
25 Way Male Plug	£0.36
25 Way Female Plug	£0.39

IDC Ribbon Mounting

9 Way Male Plug	£1.08
9 Way Female Socket	£1.08
25 Way Male Plug	£1.18
25 Way Female Socket	£1.13

Right Angled PCB

9 Way Male Plug	£0.37
9 Way Female Socket	£0.35
15 Way H.D. Socket	£0.77
25 Way Male Plug	£0.53
25 Way Female Socket	£0.51

Plastic D Covers

9 Way Cover - Grey	£0.30
9 Way Cover - Black	£0.30
15 Way Cover - Grey	£0.33
23 Way Cover - Grey	£0.36
23 Way Cover - Black	£0.36
25 Way Cover - Grey	£0.36
25 Way Cover - Black	£0.36
9 to 9 Cover / Case	£0.96
25 to 25 Cover / Case	£0.84
9 to 25 Cover / Case	£0.96

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2.5mm Jack Plug	£0.21
2.5mm Line Socket	£0.16
2.5mm Chassis Socket	£0.09
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¼" Mono Line Socket	£0.35
¼" Mono Chassis Sk	£0.35
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¼" Stereo Chassis Skt	£0.40
NEUTRIK Speakon Plug	£2.65

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4 Pin Chassis Socket	£0.26
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5 Pin Chassis Skt 180°	£0.33
5 Pin Line Plug 240°	£0.24
5 Pin Chassis Skt 240°	£0.32
5 Pin Line Plug 360°	£0.24
5 Pin Chassis Skt 360°	£0.32
6 Pin Line Plug	£0.27
6 Pin Chassis Socket	£0.35
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7 Pin Chassis Socket	£0.37
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8 Pin Chassis Socket	£0.36

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Yellow Line Plug	£0.20
White Line Plug	£0.20
Red Line Socket	£0.20
Black Line Socket	£0.20
Yellow Line Socket	£0.20
White Line Socket	£0.20
Red Chassis Socket	£0.20
Black Chassis Socket	£0.20
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3 Pin Line Socket	£1.71
3 Pin Chassis Plug	£1.50
3 Pin Chassis Socket	£1.41
Neutrik Line Plug	£1.84
Neutrik Line Socket	£1.99
Neutrik Chassis Plug	£2.13
Neutrik Chassis Socket	£2.32

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BNC Plug 50Ω Solder	£0.93
BNC Plug 50Ω Crimp	£0.62
BNC Plug 75Ω Solder	£0.95
BNC Plug 75Ω Crimp	£0.70
BNC Chassis Socket	£0.83
F Plug - Twist	£0.24
F Plug - Crimp	£0.26
TNC Plug 50Ω Solder	£1.24
TNC Plug 50Ω Crimp	£0.85
TNC Plug 75Ω Solder	£1.40
TNC Plug 75Ω Crimp	£1.16
UHF Plug 5mm Cable	£0.63
UHF Plug 11mm Cable	£0.75
UHF Chassis Skt- Sqr	£0.50
UHF Chassis Skt- Rnd	£0.73

Extensive range of RF connectors in stock, inc.FME, SMA, Mini UHF & N Type.

Terminals

Colours Red, Black, Green, Blue, White or Yellow

2mm Solder Plugs	£0.18
2mm Chassis Sockets	£0.26
4mm Solder Plugs	£0.30
4mm Stackable Plugs	£0.40
4mm Chassis Sockets	£0.23
4mm Binding Posts	£0.54
33mm Crocodile Clips	£0.13

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DC Plug 0.7ID 2.35OD	£0.47
DC Plug 1.3ID 3.4OD	£0.32
DC Plug 1.7ID 4.0OD	£0.47
DC Plug 1.7ID 4.75OD	£0.46
DC Plug 2.1ID 5.0OD	£0.24
DC Plug 2.5ID 5.0OD	£0.24
DC Plug 3.1ID 6.3OD	£0.46
DC Line Socket 2.1mm	£0.57
DC Line Socket 2.5mm	£0.56
DC Chassis Skt 2.1mm	£0.40
DC Chassis Skt 2.5mm	£0.46

IEC Mains 6A 250Vac

3 Pin IEC Line Socket	£1.08
3 Pin IEC Line Plug	£1.83
3 Pin Chassis Socket	£0.55
3 Pin Chassis Plug	£0.72

8 Way Bulgin

8 Pin Line Plug P551	£4.08
8 Pin Chassis Skt P552	£1.39

Toggle Switches

Sub-Miniature
3A 125V 1A 250V
5mm Ø Mounting Hole

SPST 5 x 10mm	£0.58
SPDT 5 x 10mm	£0.60
SPDT C/Off 5 x 10mm	£0.86
DPDT 9.2 x 10mm	£0.66

Miniature
6A 125V 3A 250V
6.2mm Ø Mounting Hole

SPST 8 x 13mm	£0.70
SPDT 8 x 13mm	£0.60
SPDT c/off 8 x 13mm	£0.60
SPDT c/o Biased 2 way	£1.10
SPDT c/o Biased 1 way	£1.04
DPDT 12 x 13mm	£0.72
DPDT c/off 12 x 13mm	£0.80
DPDT c/o Biased 2 way	£1.28
DPDT c/o Biased 1 way	£1.28

Standard
10A 250V Push on terminals
11mm Ø Mounting Hole

SPST 18 x 30mm	£1.44
SPDT 18 x 30mm	£1.42
SPDT c/off 18 x 30mm	£1.52
DPDT 21 x 30mm	£1.78
DPDT c/off 21 x 30mm	£1.78

Slide Switches

Miniature
300mA 125V
7 x 15mm Mounting Hole

DPDT 7 x 23mm	£0.20

Standard
1A 125V
5.5 x 12mm Mounting Hole

DPDT 12 x 35mm	£0.25
DPDT c/o 12 x 35mm	£0.27

Rotary Switches

150mA 250V
Make before Break 22mm Ø
9.8mm Ø Mounting Hole

1 Pole 12 Way	£0.84
2 Pole 6 Way	£0.84
3 Pole 4 Way	£0.84
4 Pole 3 Way	£0.84

Push Switches

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WELCOME

Welcome to the first combined issue of *EPE* and *ETI*. Over the last couple of weeks we have received a number of comments from readers about the "demise" of another electronics hobbyist magazine; one reader even sent us a copy from 1980 pointing out that it carried 128 pages and cost just 60p. I have not worked out the present equivalent of 60p when inflation is taken into account, but a quick look at the issue told an interesting story.

Back in 1980 the magazine carried over 70 pages of advertising from about 100 different companies; in this issue we carry 24 pages of advertising from around 40 different companies. Yes, the hobby in general has declined quite dramatically in those 19 years. In the '80s there were six UK magazines aimed at the electronics hobbyist – not including the amateur radio titles – now there are just three.

MOVING ON

The 1980 copy also tells another story which is significant; Tangerine were selling the Microton 65 "the most advanced, most powerful, most expandable microcomputer available" for £69 plus VAT – it was 6502 based, had 1K of RAM plus a cassette interface; Commodore had a page listing their stockists for the PET System "£550 for a self-contained unit" – it had 8K of RAM and ran at 1MHz (our Technical Editor, John Becker, still has a 32K version and still uses it occasionally "as a giant calculator, although not all the keys work anymore!"); Science of Cambridge carried the Sinclair ZX80 for £79.95 including VAT – 1K of RAM with a 32-character by 24-line TV display; Chromasonics and Comp Shop showed the UK101 kit (a *PE* published design) for £199 + VAT – this boasted 4K of RAM and you could buy a "colour add-on card" – an extra 4K of RAM was £32 + VAT; finally Powertran had the µComp 80 "as published in *Wireless World*" – this one cost £225 + VAT in kit form, had a maths co-processor (although they did not call it that then) and 8K of "on board memory" – another 8K cost £78.50.

Yes, this was the start of personal computing in the UK and, although we did not realise it at the time, it would lead many potential electronics hobbyists away from the electronics magazines to become what are now referred to as computer nerds. Few people realised that within the next 20 years most UK homes would own a computer of some sort.

It is, of course, interesting that those computer fanatics are now getting involved in electronics, where you can now use a PC to program PIC chips to perform your specific tasks. Of course, this leads other readers to complain that too many projects are computer based. Well, they complained when we introduced i.c.s in preference to transistors – some still do – but in this hobby we feel we must move with the times, otherwise we would still be using valves. I should point out that in 99 per cent of cases it is *not essential* to have the use of a PC to build our PIC projects.

Mike Kenward

AVAILABILITY

Copies of *EPE/ETI* are available on subscription anywhere in the world (see right), from all UK newsagents (distributed by Seymour) and from the following UK electronic component retailers: Maplin – all stores throughout the UK (and in S. Africa); Greenweld Electronics; Omni Electronics. *EPE* can also be purchased from retail magazine outlets around the world. An on-line version can be purchased from **www.epemag.com**

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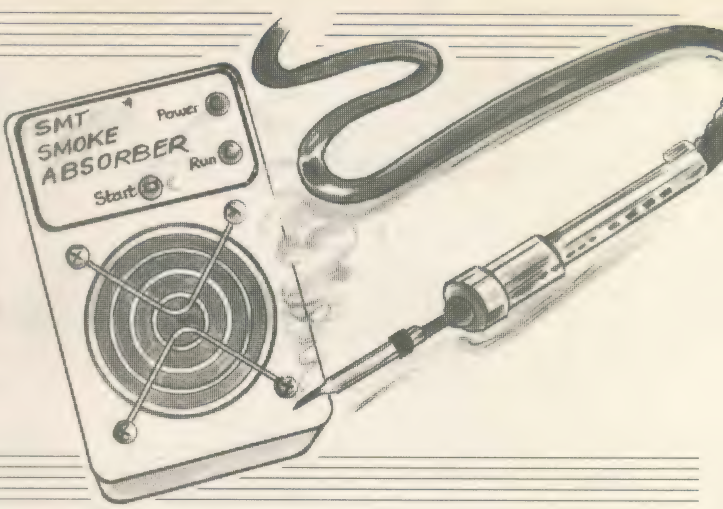
Constructional Project

SMOKE ABSORBER



BILL MOONEY

Significantly reduce your inhalation of soldering fumes.

WHEN working with tiny surface mount devices (SMDs), the constructor is drawn closer to the circuit in order to get a clear view of the soldering operation. Anyone who does soldering will have noticed the unwritten law that smoke always moves towards your face, however much you try to avoid it. Close working with SMDs therefore involves a much higher risk of solder fumes being inhaled and potential bronchial problems.

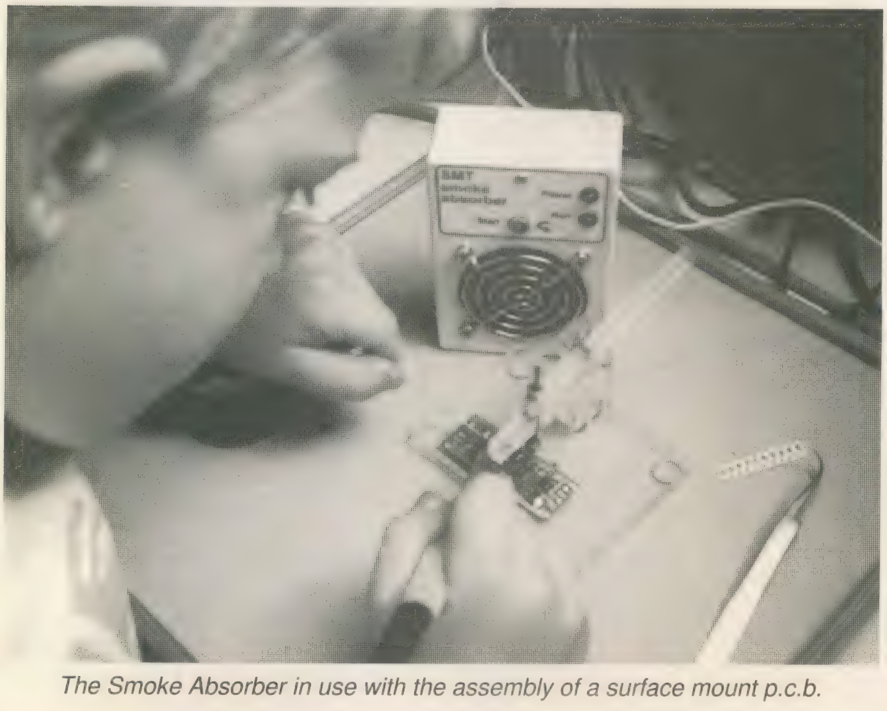
Although the smoke absorber described here was designed for use with SMD soldering, it can also be used beneficially when soldering ''ordinary'' components. It is very compact and can be placed close to the circuit board during population. It will remove the dense solder fumes from the immediate area and a built-in charcoal filter will provide a degree of filtration and absorption.

The Smoke Absorber is powered by a standard mains adaptor and after power is applied the operation is automatic. The fan is triggered by the heat from the soldering iron and it switches off after about half a minute unless re-triggered. This is a suitable time delay as the average soldering action is usually within three seconds.

Automatic control is very convenient, as the soldering process tends to be intermittent and remembering to switch the unit on and off is quite a distraction. It is also safer since it reduces the overall current drain from the power pack and can therefore remain in stand-by mode for long periods.

HARMFUL CHEMICALS

The harmful nature of solder fumes in production environments has been investigated in great depth by several organisations during recent years. The main component of common solder flux is a material known variously as rosin or colophony. This is derived from a few species of pine tree and is related to amber, which is a fossil material recovered from the sea or mined.



The Smoke Absorber in use with the assembly of a surface mount p.c.b.

Rosin is a benign material that can usually be handled and worked without problems. It is found in a surprisingly wide range of industrial and domestic products. Common applications include paper, cosmetics and soaps, chewing gum, toothpaste, varnishes, adhesives and, of course, on violin bows.

A number of people have contact allergy to colophony, in paper for example, but it is very rare. However, our concern is the risk of inhalation. Like hardwood and coal, rosin is completely safe in normal usage. But in the form of a smoke or very fine particles, these materials can be harmful, especially if they reach our lungs.

The chemical component responsible for the adverse reaction, and indeed the main component of rosin, is abietic acid. This is a member of the terpine family of which turpentine (not the substitute) will be familiar to d.i.y. enthusiasts.

There are many other undesirable components in solder smoke, including lead derivatives and, although it is not acutely toxic, it is best to reduce its intake.

CLOSE-UP WORK

Surface mount work increases the risk of inhalation of harmful vapours for several reasons. Close-in working means that any smoke breathed in will not have time to disperse and will therefore be more concentrated. There is a tendency to use higher levels of flux because good solderability is so much more important in surface mount work.

It is also possible to use solder paste for hand working with SMDs. Solder pastes and creams give off copious quantities of smoke and fumes when heated to the reflow temperature. Reflow takes place just below 200°C when the solder appears out of the grey paste as a bright metal. This clean liquid metal flows into the joint, wetting both the component contact and the printed circuit land to complete the soldering process. Solder paste fumes are mildly corrosive and should be avoided.

Commercial electronic production and servicing operations where full working day exposure is involved, take great care to remove fumes using costly extraction and filtration equipment. If the amateur envisages a lot of work with solder paste, more elaborate air cleaning or extraction should be considered. Similarly, if working in a very confined space for long periods a more efficient filtering system than this smoke absorber may be needed.

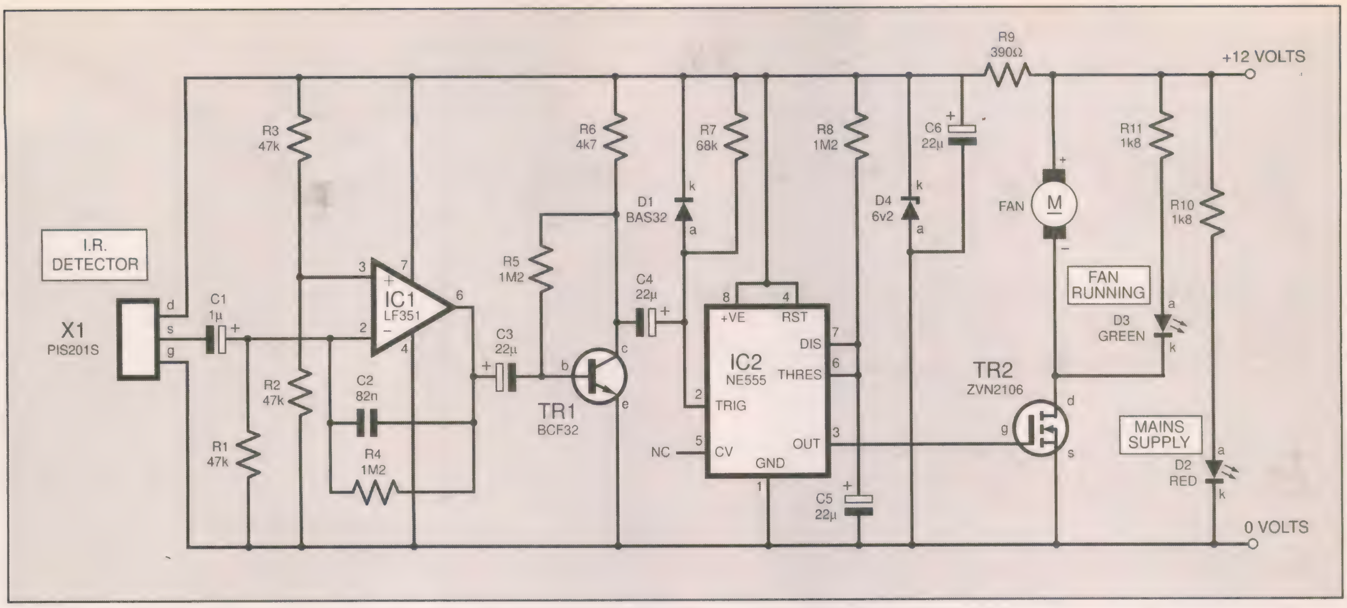


Fig.1. Complete circuit diagram for the Smoke Absorber.

This unit will help disperse the fumes reducing the concentration in the immediate working area and a certain portion will be absorbed. Complete removal of finely dispersed material from air is a complex and expensive science. We should not be too concerned about intermittent exposure to traces of rosin flux. It presents a very low risk and the faint therapeutic aroma of pine from the soldering process has pleasant relaxing associations within the cosy environment of the electronics workshop.

CIRCUIT DETAILS

The full circuit diagram for the Smoke Absorber is shown in Fig.1. A 12V 500mA regulated mains adaptor is needed to power the circuit.

The circuit is required to switch on the fan for a period of about 30 seconds and then shut it down unless it is re-triggered. Since the soldering iron is to be used in close proximity to the smoke absorber, it is logical to use the infrared (i.r.) radiation from the hot iron to start the timing cycle. The elements in the circuit are therefore infrared sensor, amplifier/filter, pulse shaper, timer and motor driver.

Detection of the heat from the soldering requires a long wave infrared detector. Semiconductor i.r. diodes and transistors are very unresponsive to radiation above about one micron wavelength. The useful heat radiation from the iron covers the wavelengths longer than about five microns and, therefore, a different type of detector is required.

Fortunately, the passive infrared sensors used in security systems work in the range of five microns to about 20 microns and are ideal for the purpose of soldering iron heat detection. The device selected was the PIS201S which consists of two pyroelectric elements wired in opposition.

At a steady level of heat radiation, the output from this arrangement is zero. The field of view of the device is about 45 degrees and the elements are arranged so that the passage of the heat source across this aperture heats up one element before the other. This unbalances the system and a momentary voltage output develops. A built-in f.e.t. (field effect transistor) source follower reduces the loading on the sensor but an output of a few millivolts is all we have to work with.

The PIS201S is not the world's fastest device with a maximum response frequency of a few Hertz. The practical circuit, shown in Fig.1, is therefore required to make this low-level signal control the filter fan.

The output from the PIS201S (X1) develops across resistor R1 which is the load resistor for the internal source follower. Op.amp IC1 is configured as a low frequency amplifier with its gain rolling off above 20Hz. The values of the coupling capacitors C1, C3, C4, and the value of the feedback capacitor C2, optimises the gain in the 0·5Hz to 5Hz range.

Transistor TR1 provides the final voltage amplification to a level suitable to trigger the type 555 timer, IC2. Whilst the trigger input to IC2 pin 2 is held high by resistor R7, the timer output on pin 3 remains low. To start the timer, a negative-going signal is required to take pin 2 below one-third of the supply voltage.

Diode D1 fully discharges C4 on positive-going signals so that a well-defined trigger pulse approaching 0V reaches the timer.

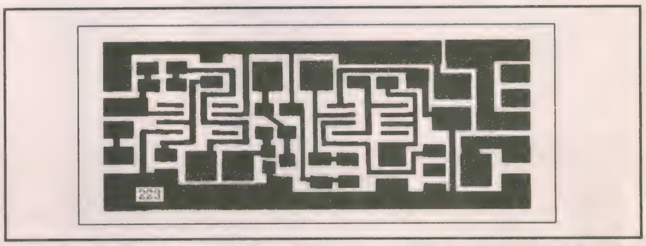


Fig.3. Full-size topside (surface mount) copper foil master track pattern.

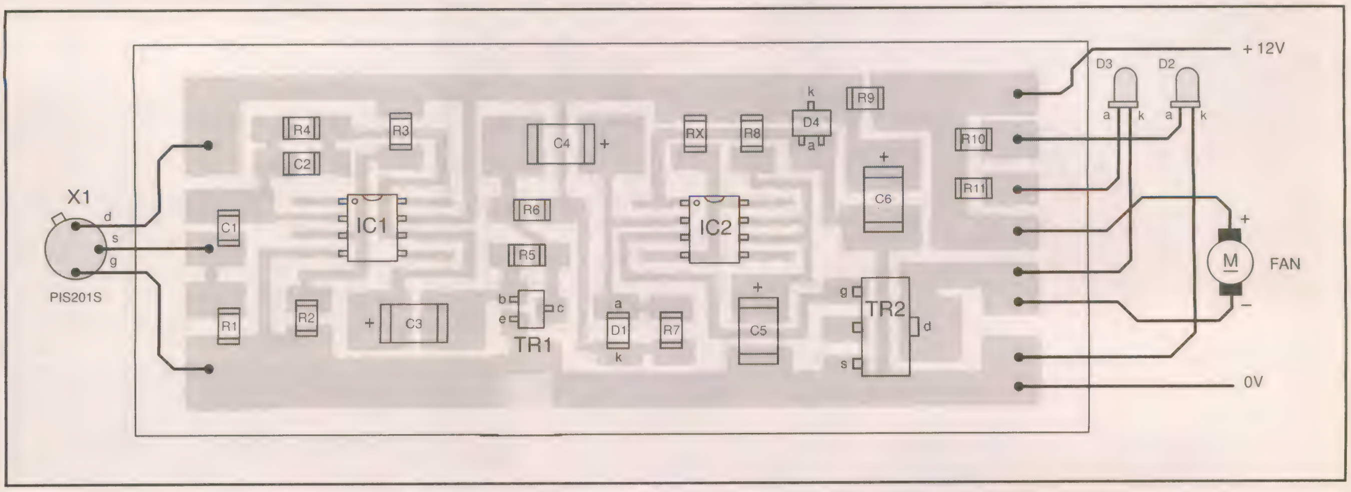


Fig.2. Component layout on the Smoke Absorber surface mount p.c.b. (twice life-size).

The timer will remain on for as long as the input on pin 2 is low. The time constant of the C4/R7 combination is therefore kept short to give a clear timing period. With the component values suggested for R8 and C5, the timer remains on for about 30 seconds.

The output of the timer, on pin 3, is high during the timing period and it can be connected directly to the motor driver TR2. This is MOSFET device, type ZNV2106, in a surface mount SOT223 package. TR2 has a very low channel on-resistance and can easily handle the 120mA required by the fan with minimal heating.

Switching the motor on and off results in a considerable ripple in the supply voltage. This must be removed in order to avoid feedback instability in this high gain circuit. A 6V supply is adequate for the low power circuits and, with a stabilised mains power pack supplying 12V, there is sufficient headroom to use a 6V2 Zener diode (D4) as an effective stabiliser.

The fan specified is a brushless d.c. type. These devices are very quiet and electrically clean in operation.

CONSTRUCTION

This is a surface mount project and it is based on readily-available SMDs. The printed circuit board (p.c.b.) component layout and track pattern are shown in Fig.2 and Fig.3, respectively. This board is available from the *EPE PCB Service*, code 223.

If you choose to make your own board, by any of the techniques as used for "ordinary" through-hole circuit boards, note that a clean surface is very important for SM work. If the p.c.b. is less than bright and shiny then a few moments spent cleaning it with a little mild household abrasive will greatly improve solderability.

After polishing, rinse off the copper surface with water or p.c.b. cleaning solvent. A light coat of rework flux from an aerosol will protect the clean surface. When this has dried the board is ready for assembly.

Although the type 0805 and smaller size chip resistors are popular in commercial production, the slightly larger 1206 sized devices are best for hand working of SM circuits, at least until some experience is gained. The overall size of the p.c.b. is determined by the size of the larger devices, in this case the tantalum capacitors, plus IC1 and IC2.

There are no tight spots in the layout and no particularly sensitive devices. All the resistors can be soldered in place followed by the capacitors and finally the active devices.

A normal 12W or 15W soldering iron can be used for SMD placement. Select the finest tip available. Standard non-corrosive rosin-cored solder will suffice for component placement, but finer 26 s.w.g. silver-loaded solder wire is preferred by the author. A pair of non-magnetised tweezers is essential for initial placement of the chips.

To solder a chip resistor in place, the most basic approach is to "fix one end first". Place the selected chip on its p.c.b. lands and hold it in position by pressing it gently with the tip of the tweezers. Now touch the end of the solder wire with the iron tip to collect a small drop of solder. Apply this to one end of the component to solder it in place. Speed is important here as the protective flux is rapidly evaporating from the molten solder drop. (Purists who observe the dictum "never carry solder to the joint" can *carefully* remake the solder joint later if they wish!)

COMPONENTS

Resistors

R1 to R3	47k (3 off)
R4, R5, R8	1M2 (3 off)
R6	4k7
R7	68k
R9	390Ω
R10, R11	1k8 (2 off)
Rx	zero ohm link (see text)

All resistors SMD 1206 package.

See SHOP TALK Page

Capacitors

C1	1µF tantalum, 16V, SMD
C2	82n ceramic, SMD 1206 package
C3 to C6	22µ tantalum, 22V, SMD (4 off)

Semiconductors

D1	BAS32 signal diode, SMD SOD80 package
D2	red l.e.d. 5mm
D3	green l.e.d. 5mm
D4	BZX84 Zener diode, 6·2V, SMD SOT23 package
TR1	BCF32 *npn* transistor, SMD SOT23 package
TR2	ZVN2106 MOSFET, SMD SOT223 package
IC1	LF351 op.amp, SMD SO8 package
IC2	NE555 timer, SMD SO8 package
X1	PIS201S i.r. detector

Miscellaneous

Printed circuit board, available from the *EPE PCB Service*, code 223; fan, 60mm 12V d.c., brushless; power socket, 2·5mm chassis mounting, 24mm fixing centres; l.e.d. mounting clip, 5mm, (2 off); plastic case, type PB1, 114mm × 76mm × 38mm; speaker mesh, Sentinel, galvanised, 22g, 6mm × 6mm holes, cut to 10 holes × 10 holes; filter, charcoal filled; finger guard, 60mm square, chromed steel (2 off); M3 nuts and bolts, 2cm long (rear finger guard and fan mounting) (4 off); M4 nuts and bolts, 6mm long (front finger guard) (4 off); mains power adaptor, 12V 500 mA, regulated; connecting wire; solder, etc.

Approx Cost Guidance Only £39 excl. power supply

As soon as the flux evaporates, oxidation of the solder surface will begin. Some residue of flux is also required for proper tinning of the component terminal and the copper pad. Pre-coating of the copper with flux is useful for this reason.

Having fixed one end, the second end can now be soldered in the normal two-handed manner where the solder and iron tip is applied to the joint at the same time.

A similar procedure can be adopted for IC1 and IC2, where two opposing leads can be soldered first to fix an i.c. in place. In all cases, the aim should be to apply minimal solder to the joint. Excess solder can be removed with solderwick. More refined methods of hand working with SMDs can be developed, but this method is satisfactory for most purposes.

Note that Zener diode D4 is an SOT23 package and the anode pins, 1 and 3, both contact the same pad. The signal diode D1 is in an SOD80 cylindrical package and therefore a little tricky to solder in place. Component Rx (Fig.2) is referred to as a "zero ohm jumper" in SM parlance and is a neat low-inductance way of jumping a p.c.b. track.

In this circuit, a 1Ω or 10Ω 1206 chip resistor would work just as well. Even a wire link could be used if necessary.

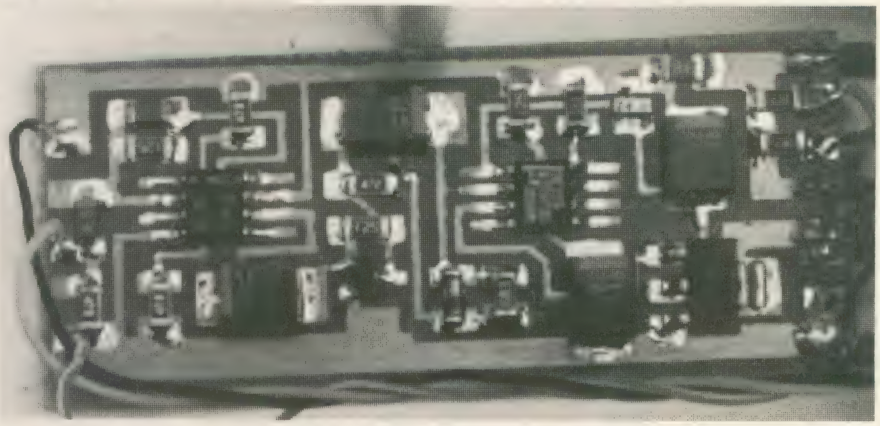
FAN BOX

The position of the fan was determined after some experimentation. Using the smoke generated by a soldering iron and rosin-cored solder it was found that the fan needs to be close to the soldering level if it is to grab most of the smoke. A height of about 1cm off the work-surface was found to be the best compromise.

Apart from taking up less bench space, the smoke removal is more efficient if the box stands on end with the fan near the bottom and the controls at the top. The arrangement of items in the author's box is shown in Fig.4.

All holes must be drilled in the box before any units are added. The fan opening was made with a standard 5·7cm diameter hole-saw. This must be done slowly because the plastic melts easily.

Next, the four bolt holes for each of the finger guards are marked and drilled. It can be seen from Fig.5 that two guards are required. The front guard is mounted on the box lid and it holds filter material in place. The second guard is mounted on the rear of the box and it shares the four fan mounting bolts.



Enlarged view of the assembled p.c.b.

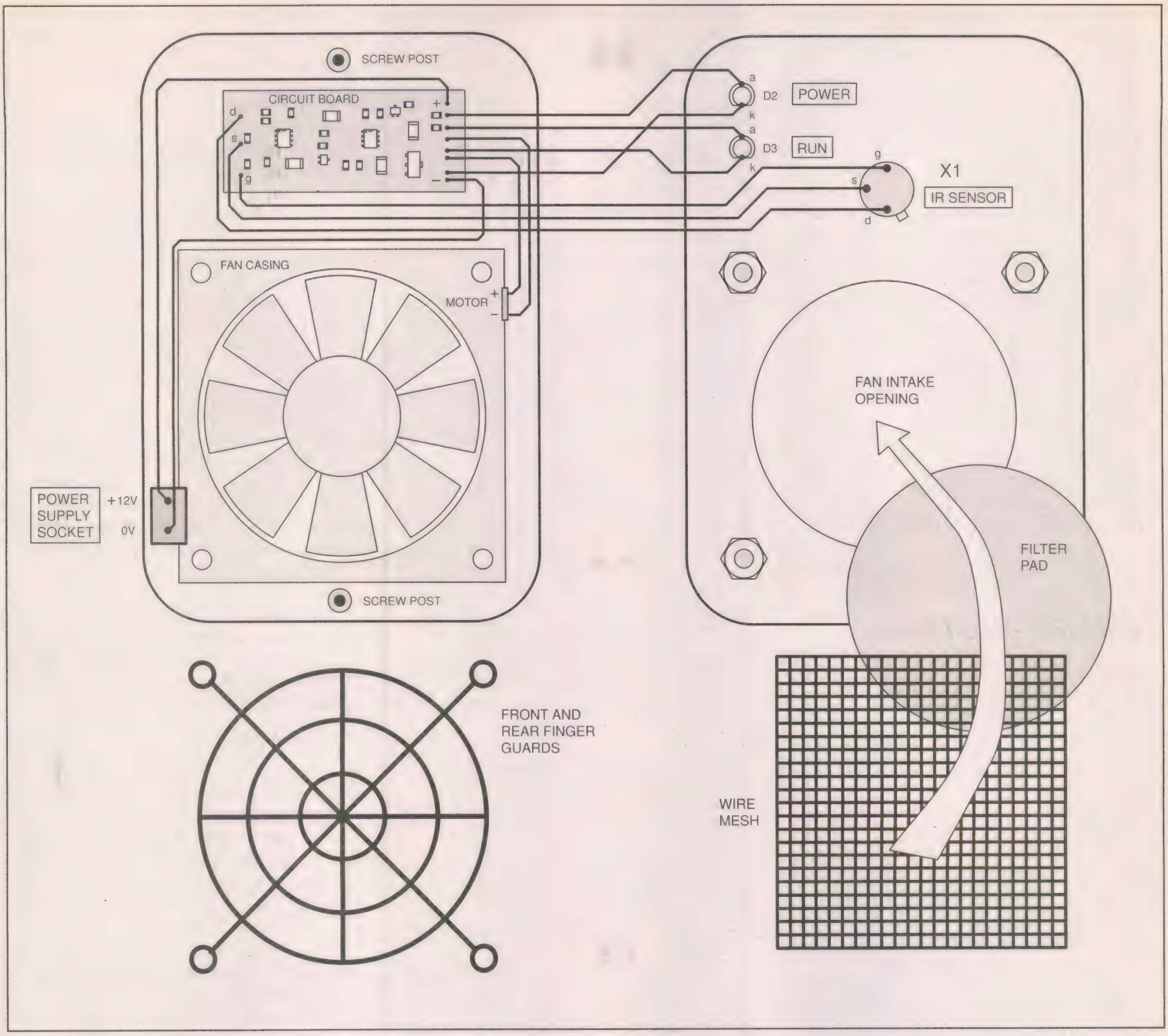


Fig.4. Internal layout and interconnections of the Smoke Absorber components within its case.

The filter foam is sandwiched between the front finger guard and a wire mesh. The foam is under slight compression and the wire mesh is necessary to prevent it from bulging into the fan blades. If a different size of box is used the sandwich technique may not work as well and the mesh may need to share the front guard bolts in order to hold the foam in place. Also, if the box is too deep the electronics may be exposed to the airflow.

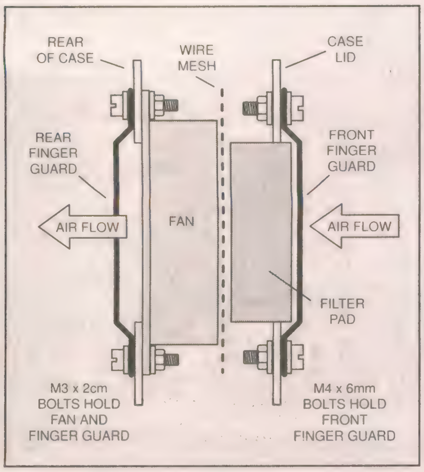
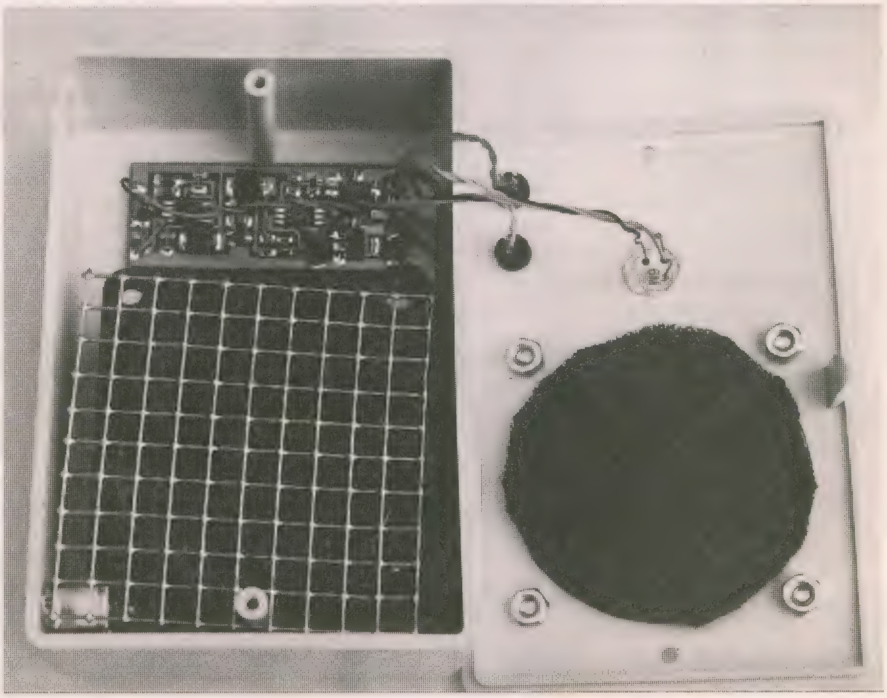
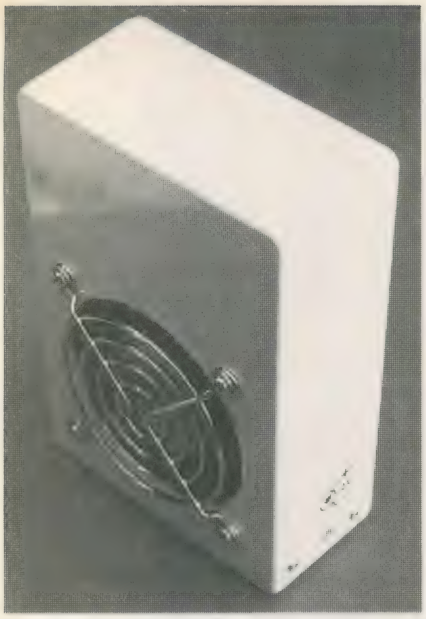


Fig.5. Side-on view of the fan assembly.



Internal layout of the Smoke Absorber.



The filter consists of open-pored foam, which is partly charcoal filled. This type of structure offers very little resistance to the passage of air. Charcoal is an excellent absorber of gaseous contaminants but in this application the flow of air is very fast and absorption may not always be complete.

As the filter material is not available in the size required, it must be cut to fit the smoke absorber. The filter sheet is easily cut with scissors to a circle just larger than the fan opening, about 6cm in diameter, so that it is a tight fit.

The galvanised mesh is cut to a square just larger than the motor housing. One of the pillars of the box passes through a hole in the mesh and with the pressure of the filter it is adequately held.

A hole must be drilled for the PIR detector (X1) to make a secure fit and a small amount of adhesive from a glue gun will hold it in place. The sensor should be fixed so that the window will be horizontal relative to the work surface.

The populated p.c.b. is held in place with a little adhesive, so avoiding the need for holes in the board or the box. Two 5mm mounting clips hold the l.e.d.s in place.

Finally, the interwiring can be completed, see Fig.4. Use the finest flexible wire available for the i.r. sensor and l.e.d. connections. Suitable colour-coded wire (as used for multi-way computer cables) makes a neater job than the rather heavy hook-up wire commonly available.

The wire in the prototype was taken from a short length of 25-way screened cable. With an overall diameter of about 0·8mm, each wire contains 7/0·1mm fine strands of tinned copper making it very flexible and ideal for small SM jobs.

Slightly heavier-duty wire is needed for the fan and for the d.c. supply socket. The circuit board pads are sufficiently large for these connections.

The motor will not function unless connected to the correct supply polarity. The red wire is connected to the positive supply rail and the blue to the driver transistor. The power connector specified uses the centre pin as positive and the smoke absorber wiring should match this.

The fan pulls air in at the front opening. It should be mounted with the motor connections and label towards the rear. This motor contains electronic driver circuitry and the supply polarity cannot be reversed.

Front panel lettering and decoration were composed using a computer drawing package and printed out as a single drawing. This label was then trimmed to size and holes cut for the l.e.d.s and the sensor. A standard paper adhesive keeps it in place. An inkjet printer is perfectly adequate for this application as the unit is unlikely to get wet.

UP AND RUNNING

A visual check of both the on-board component positions and the off-board wiring is worthwhile. In particular, check the polarity of the tantalum capacitors and make certain that the power supply socket is wired correctly.

On first switch-on, it would be wise to check the current drawn by the circuit. In stand-by mode it should draw about 20mA, rising to about 120mA in run-mode. On first application of power the fan will go into run-mode lasting for about 30 seconds and the stand-by current can be checked after this timed period.

The low voltage drop across transistor TR2 means that it should run cool even after long on-periods. The stabilised power supply is rated at 500mA which is well above the requirements of the smoke absorber and only slight warming is expected. Some experimentation will help when it comes to operation of this unit.

To start with, place the filter opening about 5cm from a circuit under construction with the exit away from the face. When the fan stops after the 30 seconds timing period it is easily restarted if required by moving the hot iron tip past the sensor at a distance of about 2cm. The heat from the tip of a finger close to the sensor window will also start the run cycle. Remember it is heat *movement* across the sensor which produces the trigger pulse to start the timer.

The smoke is warm and rises rapidly aided by the rising hot air stream from the iron tip. This is a strong effect and the stream is difficult to redirect. The path taken by the smoke will be influenced by surrounding objects which will have a chimney effect causing the plume to cling to the tallest one.

Drafts, including the body convection of the operator will also influence the plume so that, overall, its final direction is fairly chaotic. In order to catch every wisp of smoke, the absorber will need to be quiet close to the soldering operation to overcome these effects. The air stream to the fan has only a negligible cooling effect on the iron tip.

A little experimentation soon results in success in catching most of the fumes. The smoke absorber will become an indispensable part of the soldering process, particularly for the SMD constructor. ☐

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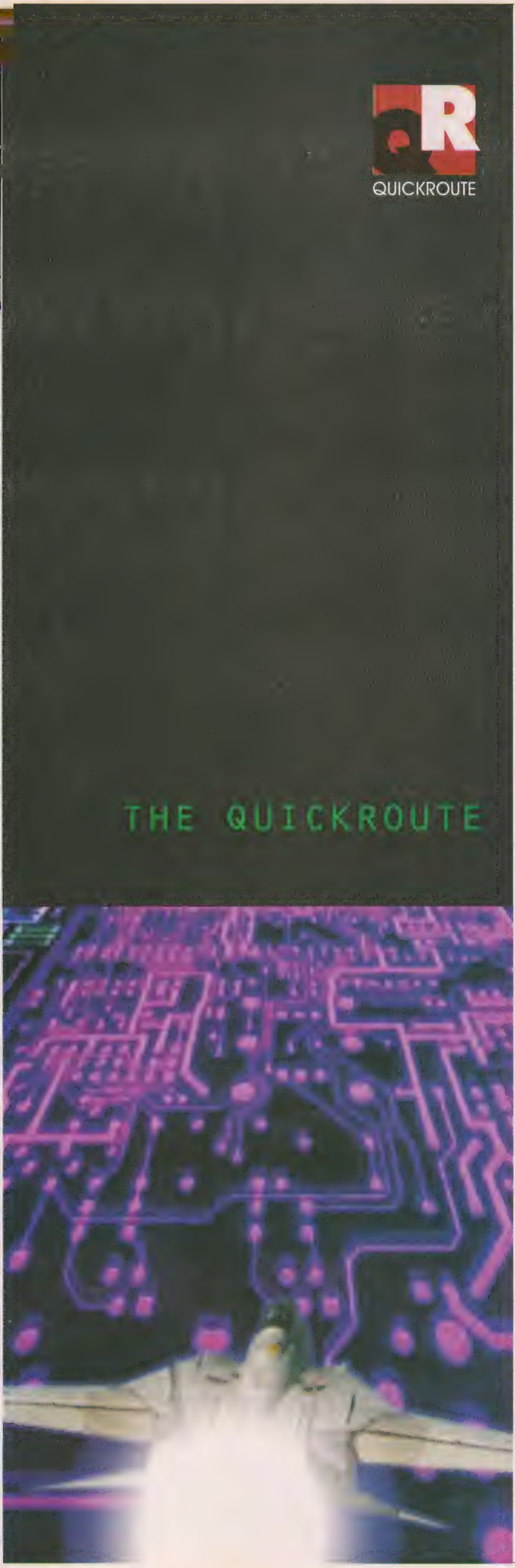

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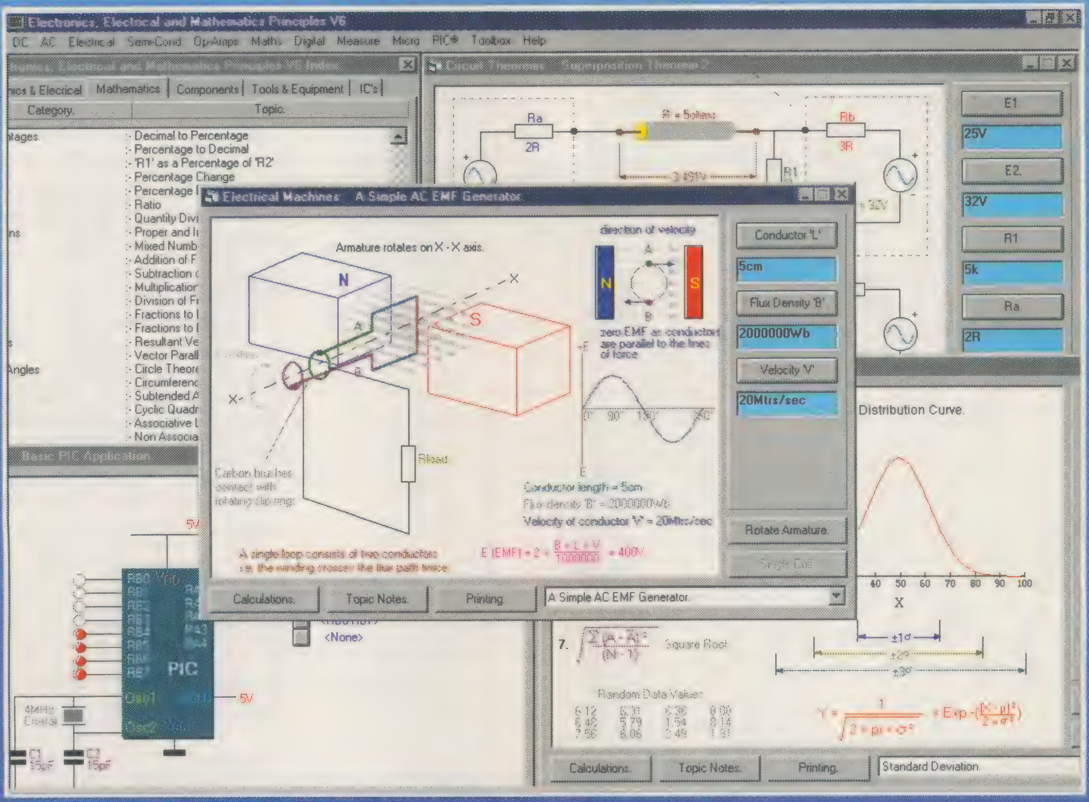
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New Technology Update

Ian Poole looks at why the "paperless" society has not happened yet and also reports on a display that uses 15 million transistors and 1·6 miles of thin film wiring.

Paper Chase

THE IDEA of the paperless society is a wonderful idea. Whilst the technology is available to achieve this in theory, everyone knows that in practice things are rather different. Despite all the technology that should enable less paper to be used, we actually use much more.

There are many reasons why the paperless office or society has not happened. It is often much easier to print out a document to read at leisure. Also, the fact that we have better and faster printers means it has become much easier to print documents.

Another reason is that printed sheets are much easier to read. There are a number of reasons for this. Reading a PC monitor causes more eyestrain because it is necessary to scroll the document up and down. In some cases it may be necessary to zoom in and out to catch the required detail.

Sometimes these fine details are not so easy to decipher because of the limited resolution of the screen. Whatever the reason the end result is the same. The documents on the screen are not as easy or convenient to read.

If the paperless office is to succeed then it will be necessary to make the technology more compatible with people's real requirements. Only when it is more convenient to read a document on the screen will people start to reduce the amount of paper that is produced.

In view of the green issues and cost savings of introducing a real paperless office, it is likely that there will be a significant uptake of the solution. As a result several companies are now working towards this end.

Roentgen

In a programme that has taken place at IBM Research, an active l.c.d. display with a resolution of 200 p.p.i. (pixels per inch) has been developed. This active matrix liquid crystal display (AMLCD) has a resolution that is near the limit of the human eye.

This prototype display is named Roentgen after the famous German physicist, Wilhelm Konrad Roentgen (1845-1923), who discovered X-rays. The display is optimised to produce exceedingly sharp images that are virtually indistinguishable from the equivalent paper copies. The jagged edges that distort curved or angled lines are virtually eliminated, making viewing far more pleasant and natural.

The screen is a further development of a monitor that was known as "Monet". This was a 10·5 inch diagonal 150 p.p.i. Super XGA l.c.d. monitor. However, IBM have been researching into high quality displays for many years and started their work into active matrix displays in the mid-1980s.

The prototype "Roentgen" screen is 21·5 inches high and 16·5 inches wide, giving it a 16·3 inch diagonal viewing area. On top of this, the total depth of the whole display unit, including the base, is only 9·5 inches – a definite improvement on the standard c.r.t. screen. The whole assembly weighs less than 20lbs, making it less than a third of the weight of a comparable size c.r.t. monitor.

There are also significant power savings over the equivalent c.r.t. It consumes less than half that of an 18 inch c.r.t., and the output luminescence is high. With a 44W back-light a brightness of 130 cd/m^2 is achieved, making it ideal under virtually all normal lighting conditions.

Many pixels

Crammed into the display are over five million full colour pixels, giving it a full 2560 × 2048 line up. To achieve this it has been necessary to use over 15 million transistors, and a staggering 1·6 miles of thin film wiring within the display.

The exceedingly high performance of the display carries some penalties with it. The screen has over four times the number of pixels of today's highest definition screens of the same size. This means that the amount of data that is required to drive it is increased. Consequently improvements are required in the computer that drives the display if the full benefits of the display are to be realised, and problems resulting from the increased amounts of data are not to be encountered.

Realising the possibility of these problems in advance, IBM researchers developed a scaleable graphics adaptor architecture. This is compatible with all the current operating systems and it is capable of handling these types of high image content displays.

A further advantage is that the adaptor is based on off-the-shelf components. This makes it a relatively cheap card to manufacture, unlike one using specialised components that would add significant costs to the whole system.

Whilst this should help in allowing people to view more data on screen, and thereby reducing the number of copies that are printed out, there will also be other uses. In the immediate future, while their cost is relatively high, they are more likely to be used in applications that demand very high levels of definition.

In particular, they are likely to be included in the ever-increasing number of databases of digital images. These include digital libraries, architectural and electronic blueprints, historical archives, and scanned records; including those used by hospitals and insurance companies.

It is also expected that with the exceedingly high level of definition and crispness there will be a high demand for this type of display for graphic design and electronic publishing applications.

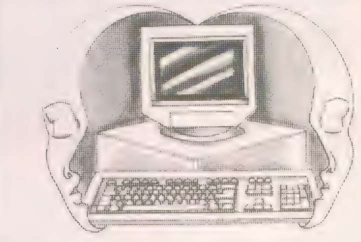
Future

Whilst there are many areas where these displays can be used, and it is expected that demand will be high, there are no plans to market the Roentgen (AMLCD) display at the present time. It is only a prototype used to prove the viability of the technology and the results of the work have given IBM a very good insight into the development and fabrication of highly complex displays. As such it has been a great success.

However, it will need developing for manufacture and at the moment IBM are in discussions with a number of customers around the world to investigate its production. This should mean that very high definition displays will be available in the foreseeable future.

To make the paperless office a reality, other developments will be required to ensure that people are as at home with data displayed on a screen as they are with that on paper. There are many reasons for wanting a document to be printed out. The convenience of being able to look at it when required, without requiring a computer, the way it looks, and the way many of us were brought up to look at paper at school rather than screens.

However, with more computers being installed in schools and the younger generation being more used to them, it is possible they may use less paper. The best way to cut down on paper usage would be to make printers less convenient to use, or much slower. Unfortunately, this is most unlikely to happen!



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News...

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CODE'S WALLOP?

Copyright protection takes on a new twist for movie disc buffs – Barry Fox reports.

HOLLYWOOD is getting tough with the computer industry. The Motion Pictures Association of America is plugging the loopholes which let a PC play unauthorised DVD movie discs. As a result consumers risk buying PC peripherals which will not work at all.

The DVD Forum, which sets the standards for DVD, requires that all DVD movie discs are encrypted with the Content Scrambling System, to prevent digital copying. DVD discs and standalone players are also Regionally Coded, to let Hollywood stagger the release of videos to tie in with the staggered release of cinema prints.

Regional coding divides the world into six zones, with North America designated Zone 1 and Europe Zone 2. Discs of one zone should not play in another.

Manufacturers of DVD playback equipment need a CSS licence. This requires that consumer DVD players leave the factory pre-coded, so that discs can be coded for the zone in which they are sold.

Although some European firms have been modifying players so that they play discs of any zone, the UK's Federation Against Copyright Theft recently raided two British dealers and seized Region 1 discs and players which had been modified to play them. FACT can prosecute because the discs were not rated for content and certificated for sale in the UK.

Locked-On

DVD movies will play on a PC, with display on a TV screen. A DVD-ROM drive and MPEG-2 decoder board cost under $250 (total) and many new PCs already come fitted with a DVD-ROM drive. Because PCs are international products, the Regional Protection Committee of the DVD Forum initially agreed that DVD-ROM drives need not be regionally coded. Instead the board comes with software which lets the user set and re-set its code up to five times. After that it remains locked to whatever was the fifth setting.

But hackers offer free software on the Internet which lets users over-ride the coding control. The Regional Protection Committee is now enforcing Phase 2 of its policy. From the end of 1999, all new DVD-ROM drives must be regionally coded. So a decoder board will only work when its code is set to match the drive. Some drive manufacturers are adopting RPC2 early. This is already causing confusion.

Sigma Designs (of Fremont, Ca) makes the RealMagic Hollywood decoder board, which boasts an "extraordinary feature" that converts TV standards so that North American NTSC movies play perfectly through a European PAL TV. The board conforms to RPC1 and lets the user set the regional code to taste, up to five times.

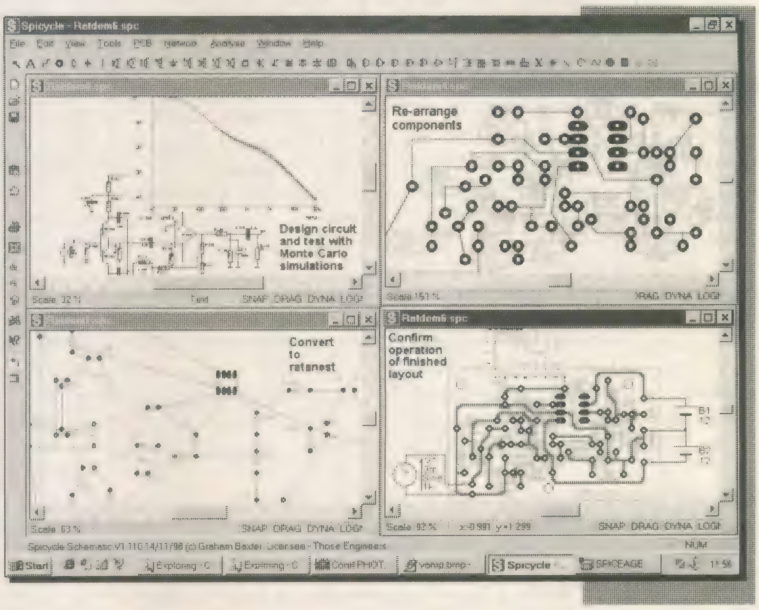
After that the setting remains locked in EEPROM memory. But if the board is used with an RPC2 ROM drive it can only play discs of the standard set by the drive. So a ROM drive bought in Europe may not work with a board set to play American discs.

Creative Labs (of Milpitas, Ca) sells the Dxr2 decoder board, and Encore DVD-ROM drive. Until October '98 the drive was not coded and the decoder zone could be reset five times by the user, and over-ridden by unauthorised software from the Internet. Now, without any formal announcement and with no warning on the packaging, Creative has started to code both the drives and boards as they leave the factory, depending on the country where they will be sold. The coding is done by chips and cannot be altered.

Panic Calls

Creative's help line is now taking panic calls from customers who have bought drives in one country and find they will not work with boards bought in another. Movie buffs are hunting in shops for old stock.

SPICYCLE



THOSE Engineers, the UK electronics CAD Specialists who pioneered mixed mode simulation with their SpiceAge simulator, have announced Spicycle, a new powerful schematic capture and PCB program as a front end for SpiceAge.

Spicycle connects to the SpiceAge simulation where you can investigate tolerances, tune component values using sweep functions, check filter suppressions, test your circuit on a range of inputs (including those grabbed from a SoundBlaster compatible card). You can even output your results to a SoundBlaster and listen to your design. Spicycle's SpiceAge simulator is independent of SPICE, though it is backwards compatible.

Amongst the many circuit and PCB design functions available, one in particular will appeal to internet-using designers. There are tens of thousands of SPICE circuits freely published on the web and Spicycle's net list import feature enables you to simulate SPICE circuits, create schematic ratsnests and to reverse-engineer these into a conventional schematic diagram. Those Engineers comment that no-one who has used the Internet for accessing SPICE data will resist this virtually limitless resource.

For more information contact Those Engineers Ltd, 31 Birkbeck Road, London NW7 4BP. Tel: 0181 906 0155. Fax: 0181 906 0969.

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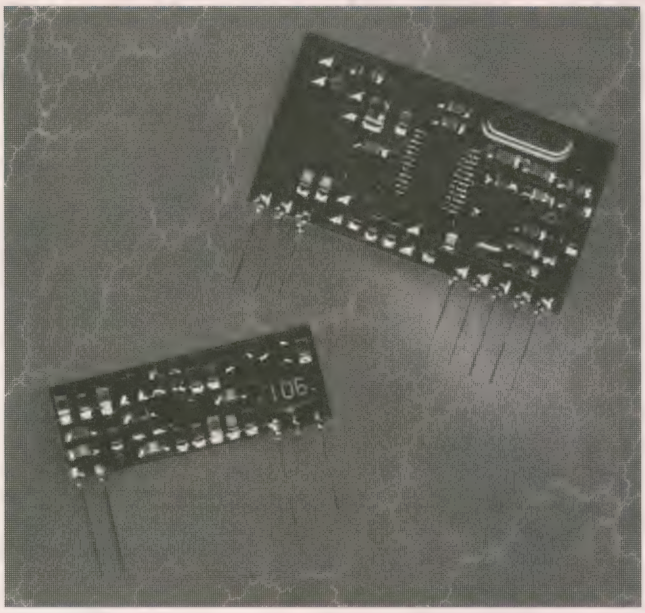


DIP International has introduced new UHF transmitter and receiver radio devices specifically designed for low power radio applications. The MK KES modules are designed for use on 418MHz, 433.92MHz and the new proposed pan-European standard of 898.95MHz.

The modules have industry-standard pin-outs and have no adjustable components for tuning, resulting in a highly shock-resistant, rugged product. Voltage requirements are 6V to 9V for the transmitters, and 5V for the receivers.

For more information contact DIP International Ltd, Sheraton House, Castle Park, Cambridge CB3 0AX. Tel: 01223 462244. Fax: 01223 467316. E-mail: antonybignall@dipinternational.co.uk. Web: http://www.dipinternational.co.uk.

YEDA '99

THE *1999 Young Electronic Designer Awards* (YEDA) programme has been announced. Staged annually since 1985 and with the enthusiastic support of HRH The Duke of York, patron since 1994, YEDA challenges young people between the ages of 12 and 25 at schools and universities, to design and build an electronic or communication device, or piece of software that answers an everyday need which they have identified.

YEDA judging is based on the same criteria as those used in industry in determining whether or not to take up a product: Is there a market need? Can it be made at the right price? Does it have unique selling features?

The purpose of the competition is to give students practical experience not only in developing their own ideas by applying modern technology, but in understanding the economics of manufacturing and marketing, so preparing them better for careers in industry. YEDA emphasises the exciting prospects offered by such careers and the important role young engineers can expect to play in the future prosperity of the country.

Prize money totalling over £10,000, together with trophies, certificates of achievement and other awards are on offer to YEDA entrants and their schools.

For further information contact The YEDA Trust, 60 Lower Street, Pulborough, West Sussex RH20 2BW. Tel: 01798 874767. Fax: 01798 873550. E-mail: postmaster@yeda.compulink.co.uk. Web: http://www.yeda.org.uk.

VIRTUAL REALITY

INTERESTINGLY relevant to our report in this issue of the VR Exhibition *(I/ITEC)*, is a recently received press release from the DTI. In it is stated that VR has become much more widespread in industry since the mid-nineties when it was used by only a handful of companies.

Over 100 organisations from 10 market sectors were interviewed for the DTI's study, being asked for their perceptions and experiences of VR technology, how they use it, where they get their information from and what VR activity they were planning.

Findings from existing users of VR include:

* 63 per cent use VR for practical use rather than simply for evaluation or pilot testing

* 88 per cent describe their experience of VR as highly or moderately successful

* 25 per cent consider VR to be "essential technology", both operationally and competitively, to their company

* 79 per cent expect to make more use of VR over the next few years, spending some £30 million on over 300 projects.

The UK Virtual Reality Forum web site is at **www.ukvrforum.org.uk**, and the Virtual Reality Awareness programme web site is on the Information Society Initiative web site at **www.isi.gov.uk**.

B.A.E.C. PLUG

NOW to give the B.A.E.C. another plug! The British Amateur Electronics Club is a worthy organisation to whom we give publicity from time to time (and who are always pleased to warmly welcome new members).

In a recent newsletter (published on a quarterly basis), we were extremely pleased to see a praising review of Andy Flind's *EPE Mood Changer* (June '98). Charles Hill, the reviewer, confesses to be in his pre-dotage years and plagued by regularly waking at four a.m. and failing to return to sleep.

To cut short an amusingly told tale, he built Andy's design and "my wife and I went to bed in some trepidation. Would it work – or wouldn't it? As usual, I fell asleep easily, and then woke a few minutes after four o'clock. After returning from the bathroom I got back into bed and that's all I can remember. Next morning my wife told me she had had a better night's sleep than usual . . . I have never looked back since".

Also of interest is that the latest newsletter gives details of new members and that in answer to the question about which mag they read, *EPE* is the most frequent answer.

To find out more about B.A.E.C., contact the Secretary, Martyn Moses, 5 Park View, Coombe Manam, Cedar View, Aberdare CF44 6PPE. Tel: 01685 877808.

E-mail: MPMOSES@compuserve.com.

Yet More on Disk!

IT was Fujifilm technology that made Zip disks a reality, allowing around 100MB of data storage space on a single disk. Fujifilm have gone yet another step further, introducing their High Density Floppy Disk (HiFD).

Still in the 3.5inch format, it can store up to 200MB, has a lightning quick transfer rate (max 3.6MB/second) and has full backward compatibility with current 2HD and 2DD floppies. It is intended to be run on Sony's new HiFD Drive. The capacity is equivalent to 139 standard 1.44HD disks.

The suggested retail price is £10.95 for a single and £19.95 for a twin pack. For more information contact your local computer specialist, or Fuji Photo Film (UK) Ltd, 125 Finchley Road, London NW3 6HY. Tel: 0171 586 5900. Fax: 0171 722 4259. Web: www.fujifilm.co.uk.

Radio Exams

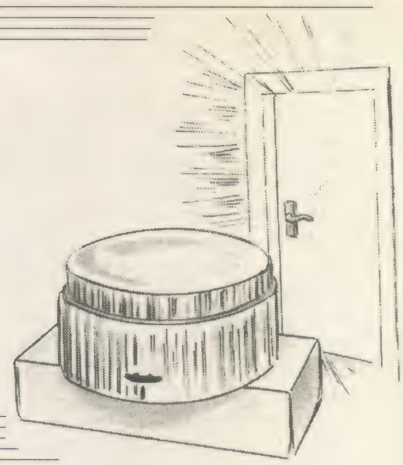
BARNSLEY & District Amateur Radio Club have asked us to publicise that their club is now a registered exam centre for the RAE and NARE. They have several courses occurring throughout the year, the first being the Novice Course which starts on 15 March, with its exam on 7 June.

For further information contact Ernie Bailey G4LUE, 8 Hild Avenue, Cudworth, Barnsley, S. Yorks S72 8RN. Tel: 01226 716339. Mobile: 0836 748958 (between 6pm and 8pm please). E-mail: badarc@cwcom.net. Web: www.badarc.mcmail.com.

Constructional Project

AUTO CUPBOARD LIGHT

TERRY de VAUX-BALBIRNIE



It is almost impossible to leave it switched on!

COMMERCIAL battery-operated cupboard lights are widely available in DIY stores and by mail order from electronic component suppliers. These lamps are useful as a simple means of lighting up a cupboard or other dark area.

They are also handy for garden sheds and other places where no mains supply exists. The fact that they are battery operated makes them particularly attractive for children's bedrooms because, unlike conventional mains lights, they are completely safe.

STRINGS ATTACHED

The most common type of cupboard lamp (and the one used in the prototype unit) uses a 3V supply comprising two D-size alkaline cells. This is sufficient to provide some 20 to 30 hours of useful operation. The on-off switch is of the string-operated variety having a pull-on pull-off action

This type of lamp suffers from one major drawback – it is too easily left switched on! This is particularly true when it is used by children (due to their impatience) and the elderly (due to forgetfulness). By the time the lamp is next needed, the batteries are likely to be "flat". With a replacement cost of some £2.50 this must be avoided if possible.

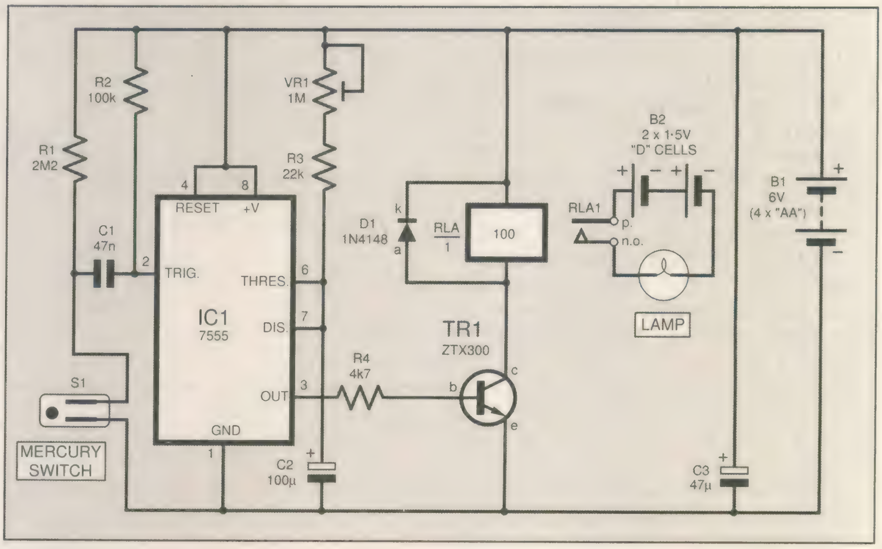


Fig.1. Complete circuit diagram for the Auto Cupboard Light. The power supply to the circuit is independent to that of the lamp.

DOOR TRIGGERED

The Auto Cupboard Light is an add-on unit for a commercial cupboard lamp designed to provide it with automatic timed operation. The lamp is triggered by door movement which makes it very easy to operate and practically foolproof in use. Before proceeding, however, check that the application lends itself to the lamp being mounted on the door.

The new add-on circuit board is housed in a plastic box attached to the base of the lamp housing (see photograph). The box is also used to secure the unit to the inside of the cupboard door. The string-operated switch is dispensed with so that control is taken over by the new circuit.

The time period during which the light operates is fully adjustable between some three seconds and about two minutes. However, this could be easily extended if required.

The lamp mounted on the circuit board box. Note that the original cord-operated switch has been removed from the lamp.

Power to the circuit is independent from that of the lamp. This comprises four AA-size alkaline cells giving a nominal 6V output.

While the lamp is off, there is a continuous current drain of some 100µA (depending somewhat on preset VR1 setting). While on, it rises to about 60mA and, in practice, the battery pack will last for many months.

CIRCUIT DETAILS

The full circuit diagram for the Auto Cupboard Light is shown in Fig.1. Switch S1 is a miniature tilt switch. This contains mercury or a small metal ball which bridges a pair of contacts when the orientation is right.

Various types of mercury and non-mercury switches were tested in the prototype and they were all capable of giving good results. However, you should choose one with *radial* leads – that is, both wires coming out of one end rather than the axial lead type (where the wires appear one at each end). The contacts are then at the end having the wires.

Switch S1 will be mounted perpendicular to the circuit board so that the end with the wires is slightly higher than the other one when the lamp is in position on the door. The contacts will then be *open*.

With a small forward movement of the switch, the contacts will momentarily close then open again due to the inertia of the material inside. In other words, the mercury or ball tends to remain still for a short time and the switch contacts catch up with it.

When the switch contacts "make", a low pulse is transferred, via capacitor C1, to the trigger input (pin 2) of IC1. This activates the low power CMOS timer IC1, configured as a monostable. The output (pin 3) then goes high for a certain time then reverts to low.

The time period is related to the values of fixed resistor R3, preset potentiometer VR1 and capacitor C2. With the values specified, VR1 can adjust the timing between three seconds and about two minutes, as mentioned earlier.

The lower limit (three seconds) will not be useful in practice. However, it was arranged that way because it will be handy for setting-up later.

To extend the operating period, it would be simply a matter of increasing the value of capacitor C2 in proportion. Note that IC1 pin 2 is maintained in a normally high condition by resistor R2 and this prevents possible false triggering. Resistor R1 provides a discharge path for C1 and maintains the upper contact of S1 in a normally high state.

In fact, the circuit will often trigger in whichever direction the switch is moved since the material inside it will bounce/flow around inside the casing and close the contacts on occasions. If the switch contacts end up normally-closed instead of normally-open, the circuit will probably still work because they are bound to break then make again.

The high value specified for resistor R1 ensures that, if this happens, the increased standby current (i.e. that flowing through R1 and the switch) is only a few microamps and negligible compared with the quiescent current of the circuit as a whole.

BACK TO BASE

While IC1 pin 3 is *high*, current flows to the base (b) of transistor TR1 via resistor R4. TR1 collector (c) current then energises the coil of relay RLA, which allows the lamp to switch on using its own 3V supply and RLA1 "make" (normally-open) contacts.

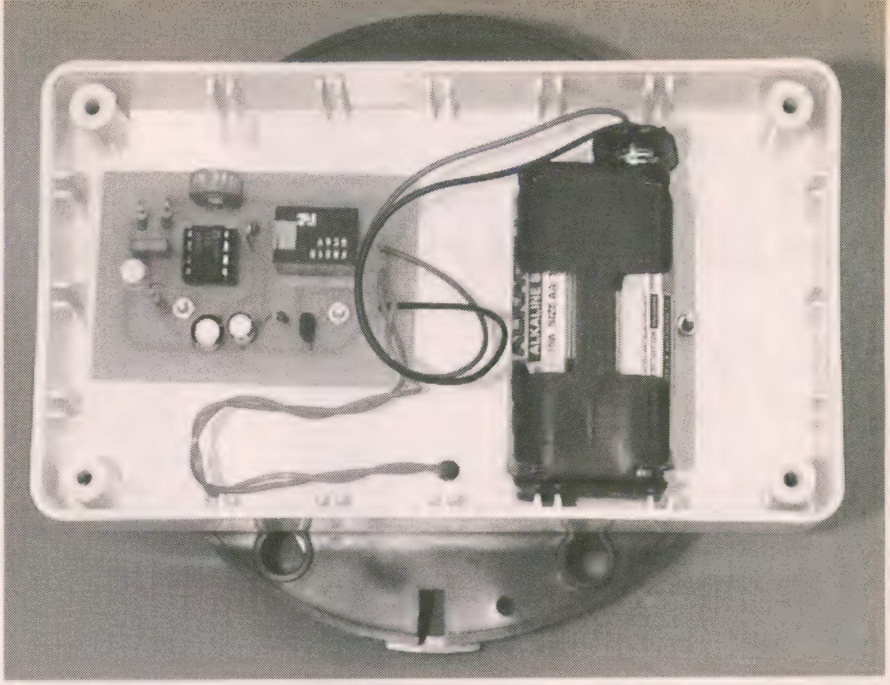
Diode D1 bypasses the reverse high-voltage pulse which appears across the relay coil when it switches off. Without it, IC1 and the transistor could be damaged.

RELAY POINTS

The choice of relay is important. Although the bulb requires only 300mA or so, the contacts should be rated at 2A minimum. This is to take account of the current surge which occurs on switching on.

It comes about because the resistance of a cold filament is much less than when it is at operating temperature. If the contacts had a lower rating, they might stick together and cause the lamp to remain on continuously. Theory predicts that an even greater current flows instantaneously but, in practice, 2A rating is sufficient.

Use of a relay allows the full battery voltage to be developed across the bulb. Other forms of switching, such as using a transistor, would introduce a voltage drop and, with the small battery voltage used here, any reduction would cause an unacceptable dimming of the bulb.



The circuit battery pack and printed circuit board mounted in position on the lid section of the box.

CONSTRUCTION

The design for the Auto Cupboard Light is based on a single-sided p.c.b. (printed circuit board) and the topside component layout, together with a full-size copper foil master, is shown in Fig.2. This board is available from the *EPE PCB Service*, code 222.

Begin construction by drilling the two board mounting holes in the positions indicated. Solder the relay, i.c. socket (but do not insert the i.c. yet), fixed resistors, preset potentiometer and capacitor C1 in place.

Next, add capacitors C2 and C3 also the transistor observing their orientation. Finish with the "tilt" switch, mounting it so that the end having the leads is about 3mm higher than the plain one (when the p.c.b. is held vertically as shown in the photographs). This will give a reasonably correct sensitivity setting.

Solder 15cm pieces of light-duty stranded wire, together with the battery connector leads, to the lead-off copper pads as indicated in Fig.2. Adjust the preset VR1 fully anticlockwise (as viewed from the top edge of the p.c.b.). This will give the minimum three second timing, which is suitable for testing.

SHUT THAT DOOR

To make the lamp come on as the door is opened, the p.c.b. needs to be mounted on the top section of the box (see photographs). This will give the correct direction of movement. The box used in the prototype (see *Shoptalk)* has a deep lid section making this work convenient.

A position should be chosen for the p.c.b. and battery pack. Mark and drill the p.c.b. fixing holes but do not actually attach it yet.

Remove the plastic dome of the lamp housing and take out the bulb and cells. Locate and remove the "built-in" switch to leave free ends. How this is done will depend to some extent on the lamp being

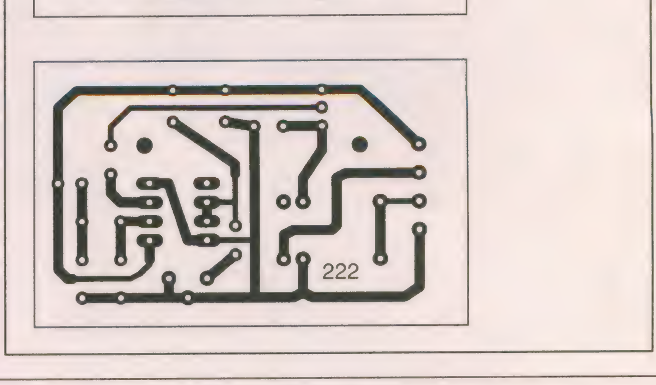


Fig.2. Auto Cupboard Light printed circuit board component layout and full size underside copper foil master pattern.

COMPONENTS

See SHOP TALK Page

Resistors

R1	2M2
R2	100k
R3	22k
R4	4k7

All 0·25W 5% carbon film

Potentiometer

VR1	1M min. enclosed carbon preset, vertical

Capacitors

C1	47n polyester, 5mm pin spacing
C2	100μ radial elect. 10V
C3	47μ radial elect. 16V

Semiconductors

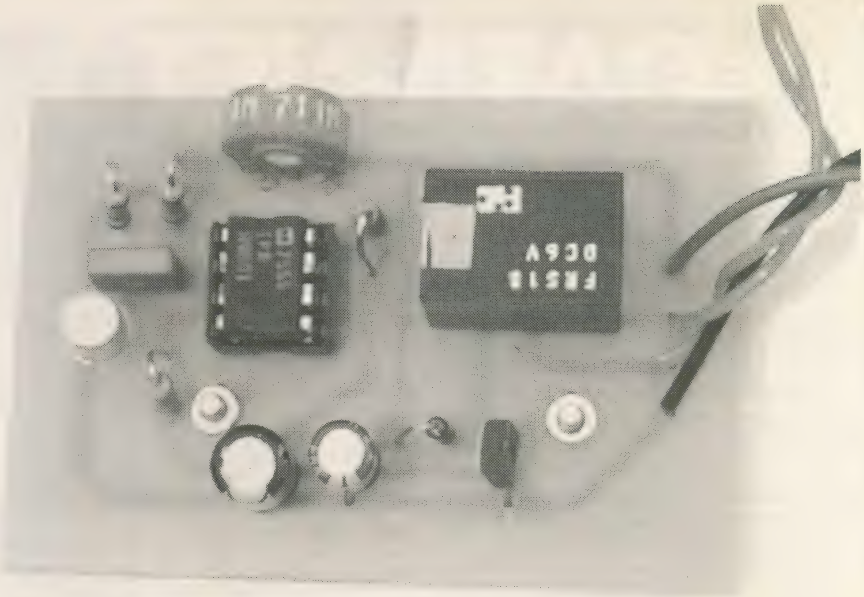
TR1	ZTX300 *npn* transistor
IC1	ICM7555IPA low power CMOS timer

Miscellaneous

S1	miniature tilt switch - see text
RLA1	min. 6V 100 ohm coil relay, with 2A normally-open or changeover contacts.
B1	6V (4xAA cell) battery pack, with holder and PP3 type connector and leads

Printed circuit board available from *EPE PCB Service*, code 222; cupboard lamp, see *Shoptalk* page; ABS plastic case, size 143mm x 82mm x 44mm external; 8-pin d.i.l. socket, multistrand connecting wire; solder pins; solder etc.

Approx Cost Guidance Only Excluding Batts. & Lamp £14



Layout of components on the completed p.c.b. Note that the metal cased tilt switch, to the left of the i.c., should be carefully bent so that the wire end is slightly higher when the unit is mounted on a door.

used. However, in the prototype, it was a straightforward job.

By inspecting the internal details of the lamp and taking account of the p.c.b. and battery pack positions, mark and drill two holes in free positions and drill these through the lamp base and the box. “These will be used to secure the lamp in position.

Mount the p.c.b. in position using countersunk screws (so that the lamp will be flat on the top). Attach the lamp unit to the box using small nuts and bolts. Drill a small hole for the wires leading from the p.c.b. to the lamp and solder them to the contact strips where the switch used to be.

Insert the AA cells (B1) into the battery holder and attach it using adhesive Velcro fixing pads or in some other way which will make it easy to remove for battery-changing purposes. Do not connect it up yet, however. Replace the cells and bulb in the lamp.

Insert IC1 into its holder. Since this is a CMOS device, it could be damaged if there is any static charge on the body. To be safe, remove any charge by touching an earthed metal object (such as a water tap) before handling the pins. Mark the positions of the two keyhole slots for mounting the unit on the cupboard and cut these out.

FINISHING OFF

Connect the battery holder. With the lamp held as it will be on the door, gently move the unit. The monostable will trigger and the lamp should come on if it has not already done so. If you keep the case stationary, it should then go off after a few seconds.

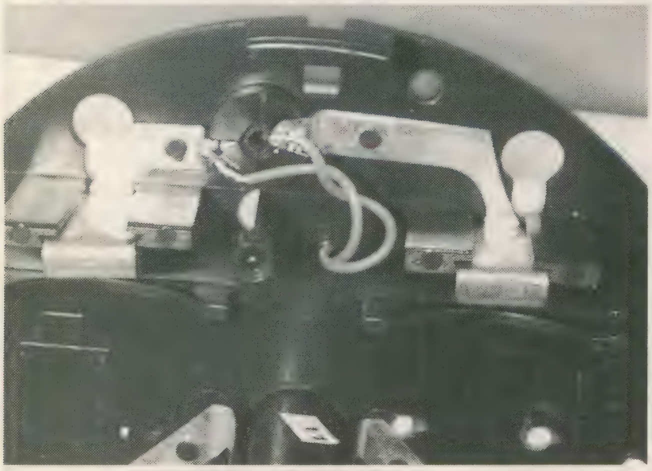
Assemble the box using only two of the screws for the moment. Fix the unit to the door and wait for the lamp to go out (it will almost certainly come on again during the movement). Open the door normally – the lamp should operate again.

If it does not do this, or if it needs a particularly harsh movement to make it work, reduce the angle of the switch and re-try. A position should be found where it is neither too sensitive nor too difficult to operate.

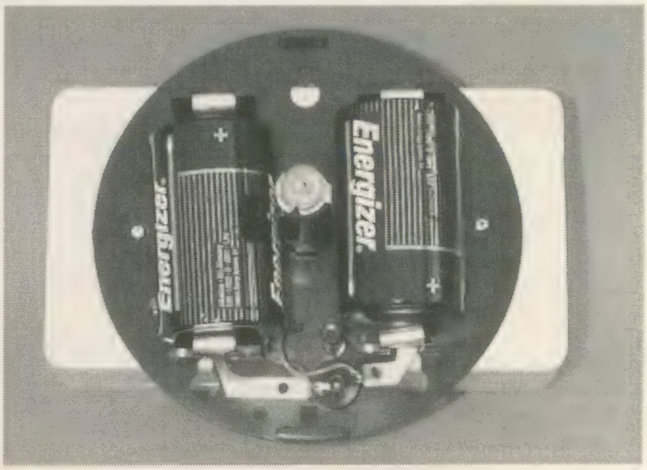
Possibly, it will need a period of “trial and error” to get this adjustment just right. Do not leave VR1 at minimum adjustment because the standby current requirement is increased. So, set it to provide a suitable timing period.

Secure the remaining screws in the box and attach the plastic dome on the lamp. Mount the unit on the door.

When the lamp is turned on, try to close the door before it goes off. If you do not, it will probably re-trigger when you close it and drain the batteries unnecessarily. □



The original cord-operated switch has been removed from the lamp and the wires from the p.c.b. are soldered to its former position.



The D-cells and bulb replaced in the finished Auto Cupboard Light unit ready for receiving the light diffuser dome.

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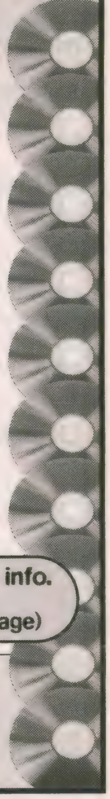

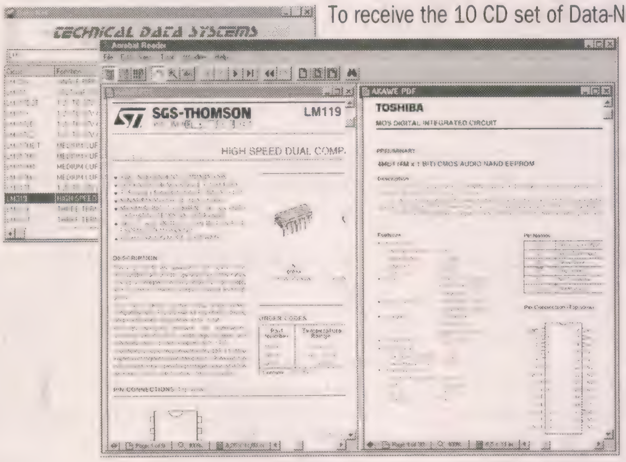

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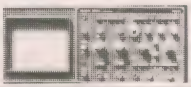

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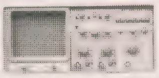

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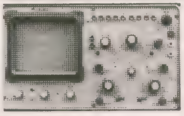

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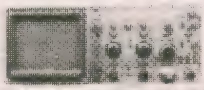

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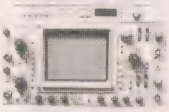

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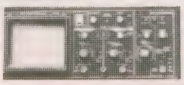

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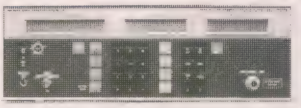

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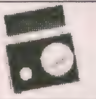

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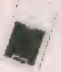

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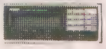

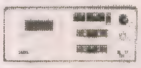

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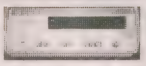

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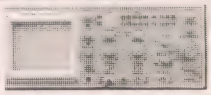

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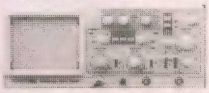

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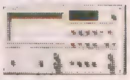

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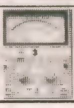

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I/ITEC SHOW REPORT

CLIVE "MAX" MAXFIELD

A special report from the land of virtual reality at the Interservice/Industry Training, Simulation and Education Conference in Orlando.

IT'S rare that you see something you believe could make a significant impact on the world, but this happened to me at the beginning of December, 1998.

One of the more interesting conferences and trade shows of the year is *I/ITSEC (Interservice/Industry Training, Simulation, and Education Conference)*, which is held in Orlando, Florida, USA. This conference is unusual in that it is held immediately after Thanksgiving weekend, but it was explained to me that this gives the American Generals an excuse to bring their families to Walt Disney World, so that's OK.

The reason I/ITSEC is so interesting is that it offers a showcase for the state-of-the-art in computer-based visual simulation and virtual reality. Governments spend huge amounts of money on training, and in today's restricted economy they want to get the "biggest bang for their buck".

For example, by the time you take into account wear and tear, fuel, cost of munitions, and environmental impact, it can cost as much as $100,000 US dollars every time you start up a tank (and this doesn't take account of the danger to personnel that is inherent in live-fire exercises)! In fact, the National Training Systems Association estimates that US government investment in modeling and simulation (M&S) is currently running at about $3 billion US dollars per year, which equates to some honking big and mega-cool flight and tank simulators, let me tell you!

MODELLING THE WORLD

The company that almost blew my socks off and takes my personal "most amazing idea" award is Geometrix Inc, San Jose, California (**www.geometrixinc.com**). The first product from this small (12 person) company is 3Scan, which provides a way of quickly creating models for use in 3D visualization, simulation, and animation environments. The idea is that you put the object to be scanned on a computer-controlled turntable and scan it with a single video camera (Fig.1).

The camera I saw them using was a $120 "cheap-and-cheerful" version, you could get significantly better results with a more expensive unit. Once you've instructed the computer how many images you want to use, it automatically rotates the turntable and captures the appropriate data; for example, 20 images equals 18 degrees between images.

The key points here are *standard video camera* (i.e. no lasers or anything like that), and *just one camera*, which means that you don't require multiple cameras for stereoscopic viewing to calculate depth.

Once the scanning process is finished, the 3Scan program examines the first frame to locate and identify key features in the image (the algorithm that does this is pretty sophisticated in its own right). The program then determines how far each of these features moves from frame to frame. Also some features become obscured and others become visible as the object rotates, so the program adds new features and discards old ones as it proceeds.

The program uses parallax to determine the relative positions of each of these key features (which ones are closer and which ones are further away). (In this context parallax is the apparent displacement of each of the features from one frame to another.)

The end result is that 3Scan processes the raw video data and generates a very tasty 3D model with appropriate textures

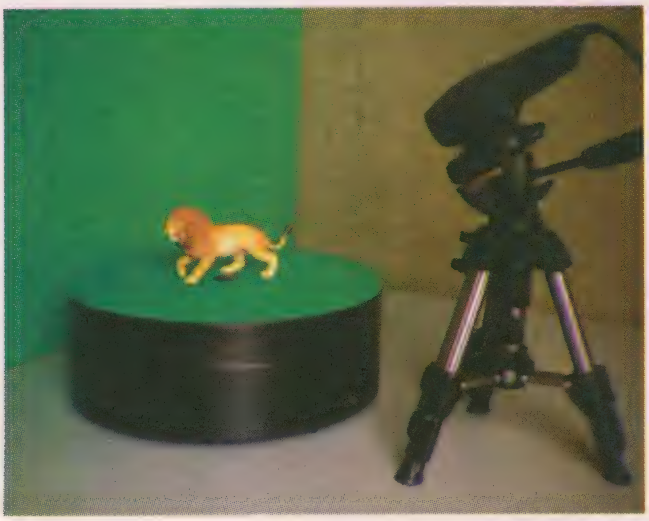


Fig.1. The 3Scan set-up with simple turntable and single video camera.

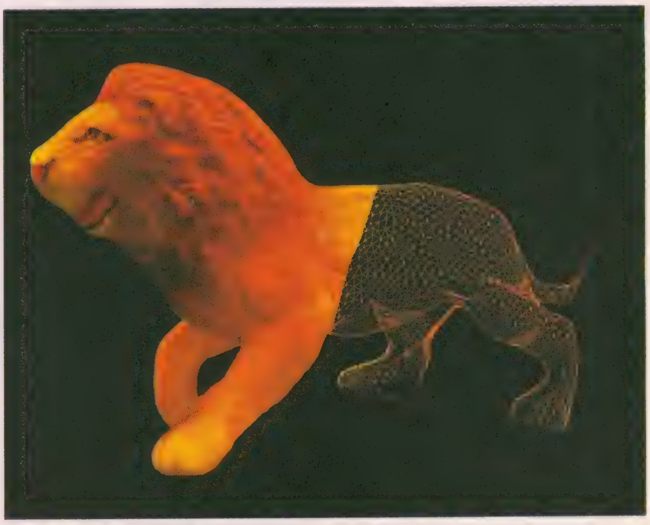


Fig.2. The model generated by 3Scan.

(Figs. 1 to 7 courtesy Geometrix Inc)

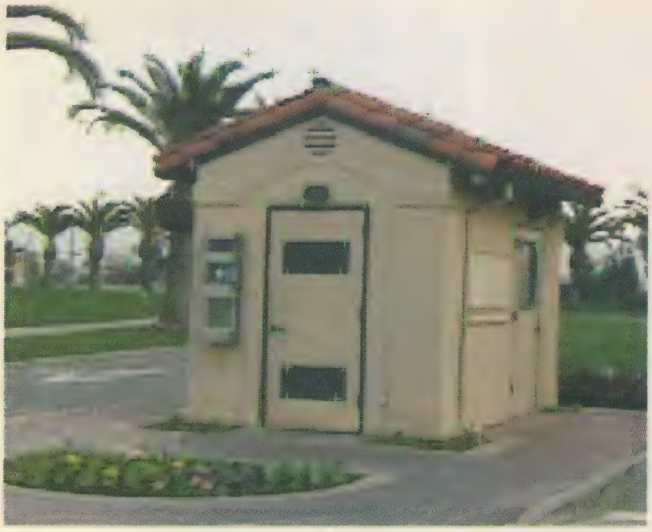


Fig.3. Original SoftScene picture with features indicated.

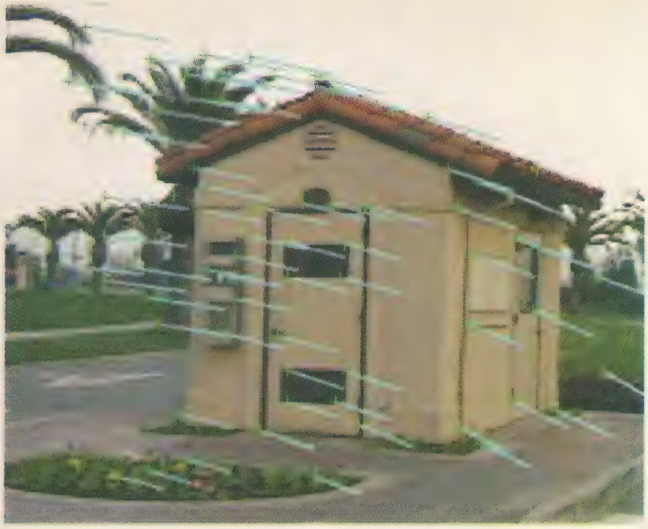


Fig.4. Showing the image displacement vectors.

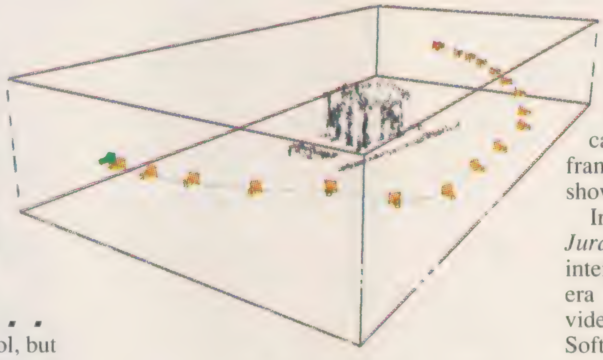


Fig.5 (right). Reconstructed camera path with "point cloud".

(surface characteristics), see Fig 2. These models are essentially a mesh of polygons (triangles) with textures applied to them. This means that the models wouldn't really be suitable for individual animation, but they would make great general-purpose models for inclusion in 3D scenes.

BUT THEN I SAW . . .

I thought that 3Scan was pretty cool, but then the guys from Geometrix introduced me to SoftScene, which is where things start to get really amazing. With SoftScene, the clever rascals have extended the 3Scan concept to allow someone with a single hand-held camera to, say, walk around a building filming it.

As for 3Scan, SoftScene uses advanced image processing algorithms to detect and extract prominent visual features in the scene (Fig.3). In this image, green crosshairs indicate features that have been detected in the current frame.

SoftScene tracks the prominent features from frame to frame, re-invoking the feature extraction algorithm whenever additional features are required. In Fig.4, cyan lines are used to indicate the *image displacement vectors* of the selected features (the green crosshairs indicate where the features are in the current frame). SoftScene then employs advanced *structure-from-motion* algorithms based on analyzing motion parallax to spatially locate the tracked features.

One very clever aspect of all of this is that the person holding the camera obviously isn't going to walk around the building following an exactly circular path. So one of the things the SoftScene program has to do is to calculate the path of the camera in order to compensate for the operator moving closer to and father from the building. The image in Fig.5 shows the fully reconstructed camera path along with a "point cloud" representing the final set of tracked features in 3D space. The green and red camera icons represent the first and last frames, respectively (camera icons are shown 12 frames apart in this image).

In fact some people (like the creators of *Jurassic Park*, for example) are really interested in knowing the path of the camera for the purposes of combining live video with animated characters. Using the SoftScene process, they could just give the program a video clip and it could tell them the path of their camera (this is essentially a product in its own right).

But returning to our building, to complete the process SoftScene uses advanced topology and computational geometry algorithms to construct a polygonal mesh from the data contained in the 3D point cloud (Fig.6). Textures are then automatically extracted from the video imagery and applied to the surfaces of the model, resulting in the model shown in Fig.7.

We should note that this was an early beta of the SoftScene program — Geometrix are planning on formally unveiling the full product at the *Siggraph* conference in mid-1999. Also, Geometrix

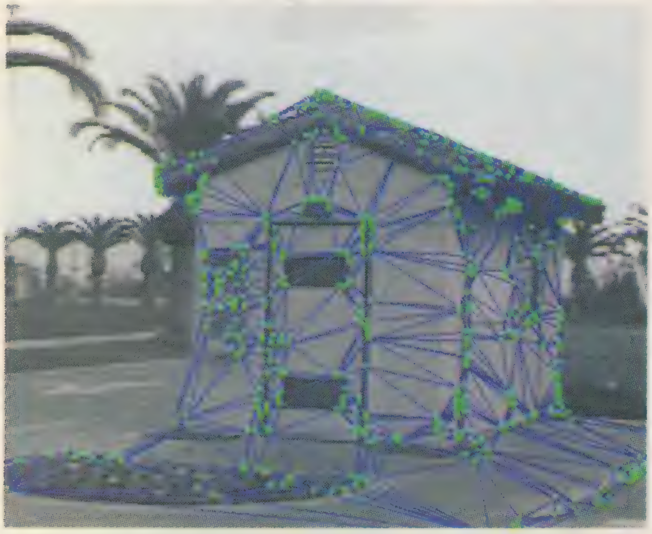


Fig.6. Polygonal mesh constructed from the data in the "point cloud".

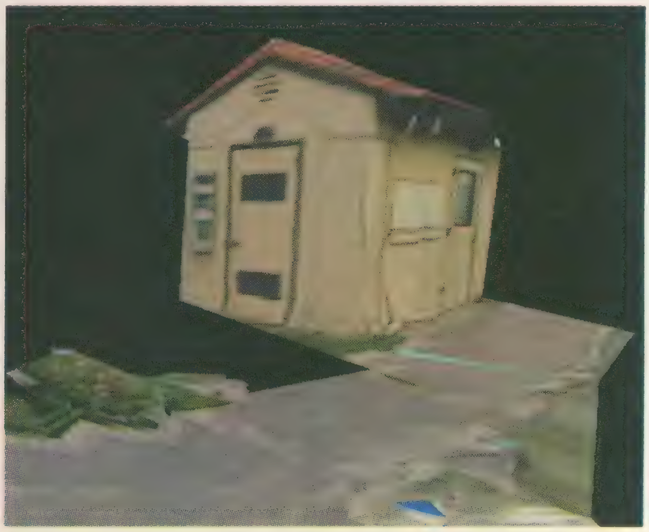


Fig.7. The 3D model generated by SoftScene from the original video.

have recently been awarded $950,000 in development funding to attach a GPS receiver to the camera and to record GPS data on the audio track of the video, which will allow them to generate extremely accurate models.

TREMENDOUSLY EXCITING

I think that the SoftScene technology is tremendously exciting. It seems to me that there are almost limitless applications in all walks of life that would benefit from the ability to create models using this technique. For example, imagine a police officer at the scene of an accident walking round with a video camera filming everything. Later, that video could be converted into an accurate 3D model that you can "walk through". This would make it much easier to evaluate whether people could see what they said they saw from the positions they said they were in, and so forth.

Another potentially interesting market is television studios, which are increasingly making use of "virtual sets". These computer-generated sets offer many advantages, such as the fact that you don't have to set them up, take them down, or store them, and also that you can quickly and easily change things like colours and textures. The problem is that creating 3D computer models for these virtual sets can be extremely time-consuming, SoftScene technology would make creating the models for these virtual sets *much* easier.

Geometrix emphasize that their technology is not currently targeted towards the commercial (home) market, but I can also see many potential applications here. For example, imagine filming the inside of your house with your video camera and using SoftScene to create an accurate 3D model of your home. This would allow you to experiment with alternative decors in a virtual environment — the possibilities really are endless!

EYE EYE . . .

Several companies were demonstrating eye-tracking systems, including SMI (SensoMotoric Instruments from Germany, **www.smi.com**) and ASL (Applied Science Laboratories, Bedford, Massachusetts). The most sophisticated version is attached to a head-mounted assembly, with sensors that track the position of each eye (and the size of your pupils and suchlike). This data can then be displayed on a computer screen superimposed on an image of what you were looking at at the time. This lets you model the path the observers' eyes took, combined with other data such as how long the eyes rested at each point.

Applications for this sort of technology range from flight simulators (for example to see what instruments the pilot looked at and in what order during a simulated emergency) to web marketing (to see how users read web pages — what they look at and what they miss or ignore).

Although the head-mount unit was a little obtrusive, it did have the advantage that it was position-sensitive, which allows the system to compensate for movements of the head. Also, this would be far less obtrusive if it were mounted directly into a fighter pilot's helmet, for example. Of course, applications of the web-marketing ilk don't require this level of sophistication, and simpler units are available that can be mounted on your desk or on top of the computer screen to track your eye motions from that perspective.

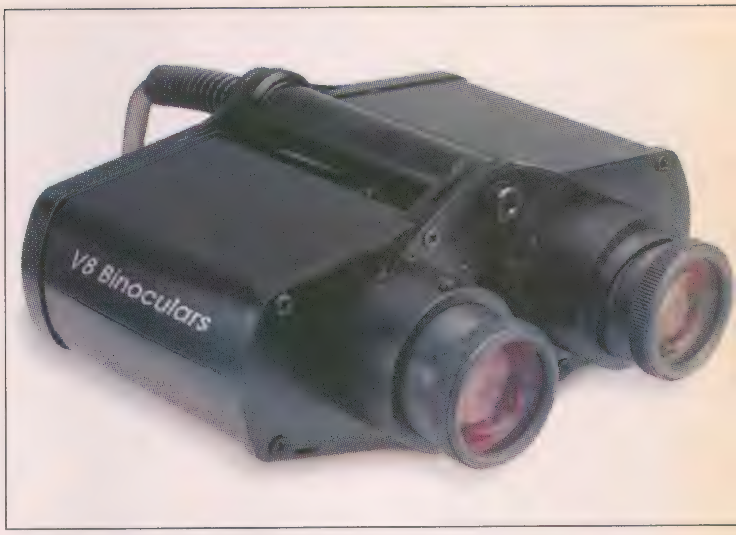


Fig.8. V8 virtual binoculars (Photo courtesy Virtual Research Systems Inc.)

I SEE NO SHIPS . . .

Another technology that scored high on my "cool-meter" is the concept of virtual binoculars, which were being displayed by companies such as Virtual Research Systems Inc, Santa Clara, California (**www.virtualresearch.com**) and n.Vision, McLean, Virginia (**www.nvis.com**).

These little rascals look and feel like a standard pair of binoculars — for example, you can adjust the focus of each eye, widen or narrow the spacing between the eyes, and so forth. The difference being that the images seen by each eye are generated by a computer connected to the binoculars and displayed on small l.c.d. screens inside the binoculars (Fig.8).

One clever aspect of this is that the binoculars track their position in 3D space, so as you turn your head (and body) the scene changes appropriately. For example, when I looked through them, I could see a plane coming towards me and passing overhead, and by moving my body I could track the plane, zoom in on it, and so forth.

This sort of device can be very useful for such tasks as training forward observers to recognize planes and vehicles in a battlefield situation without the cost of actually fielding the real units.

IF AT FIRST . . .

Whenever I hear the term "simulators" I think of flight simulators (e.g. planes and helicopters) or vehicle trainers (e.g. tanks and suchlike), so I was somewhat surprised when I meandered into the booth of Jason Associates Corporation, Draper, Utah (**www.jason-sed.com**) to find a smorgasbord of crane simulators.

The idea is that you sit in a seat from a real crane (well, a seat made by the same company that makes the seats for the real cranes) with real controls, facing a large screen showing the load on the end of the hoist, and then you practice, and practice, and . . . See Fig.9.

Of particular interest was a dock-side simulator that modelled the effects of the swell of the sea, the motion of the ship, the effects of the wind on the load, and so forth (in the more sophisticated units the seat has motion and the controls have tactile

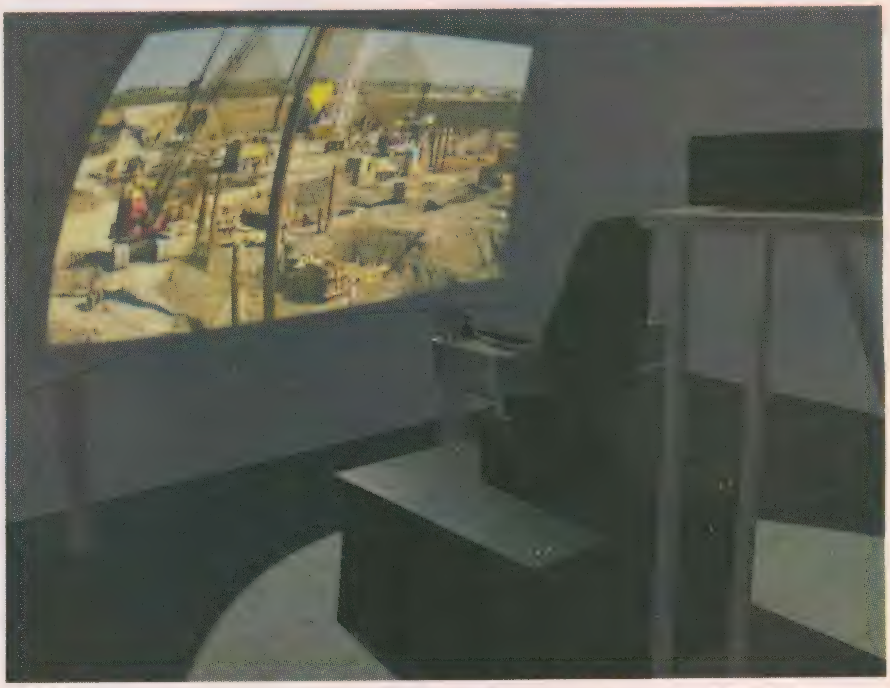


Fig.9. The Virtual crane simulator from Jason Associates Corp.

feedback). It obviously makes a lot of sense to practice this sort of thing in a virtual world before you are let loose on a real crane.

Jason Associates started off modeling cranes for military applications, but now they're moving into the commercial area. As the representative I was talking to said: "Have you any idea how many cranes there are in the world?" I must admit that I hadn't previously spent a lot of time pondering this poser, but it certainly makes one pause for thought.

VISIONDOME

If you place your hands to either side of your head, and restrict yourself to about a 60 degree field of view, the resulting image is approximately the same as you see on a computer screen. Some applications, however, require a greater field of view to fully immerse you into the simulation.

One very nice solution demonstrated at I/ITSEC was the VisionDome from Alternate Realities Corporation, Durham, North Carolina (**www.virtual-reality.com**.), see Fig.10. These little beauties range from 5 metres wide by 3 metres high (for two to five viewers) up to models that are 8 metres in diameter and can accommodate over 45 viewers.

The nice thing about the VisionDome is that it provides a fully immersive multi-user virtual reality environment without requiring goggles, glasses, helmets, or other restrictive devices. This makes the VisionDome an ideal choice for multi-user simulations, training, design, engineering, and so forth. For example, the virtual crane simulations discussed above would be even more realistic if they were to use a VisionDome as their display device.

As I was to discover, there are three very clever portions to this system:

The dome itself
The projector/lens
The software

THE DOME

The reason I say the dome is clever, is that the way it is constructed makes it extremely portable and easy to erect. First of all you raise an aluminum frame, then you clad the outside of the frame with a thick black covering and the inside with the white lining material.

The cunning part of all this is that if you were to try to attach the white lining to the struts of the frame, you would end up with distortions on the surface of the dome. Instead, the white lining is only attached around the edges of the frame, then a small pump is used to create a slight negative pressure by sucking out the air from between the black cladding (on the outside of the frame) and the white cladding (on the inside of the frame). This results in the inner lining being stretched taught and forming a perfect hemisphere.

PROJECTOR AND LENS

The next interesting point is the projection system. Instead of having red, green, and blue "guns", the VisionDome employs a single-unit projector, which means that there's no problems with alignment. But the really clever part of the projection unit is the lens, which somehow manages to project a perfectly focused image across a 180 degree field of view.

Furthermore, this lens has an infinite focal length. This means that you can hold a piece of paper a few inches from the lens and see that portion of the image in focus. Then as you move the paper further and further away the image stays in focus without any correlation problems. I don't have a clue how this works, but the end result is that the image is in perfect focus at every point inside the dome.

THE SOFTWARE

Last but not least is the software. In order to appreciate what this does, you first have to understand a few basic concepts about 3D graphics. First of all, a 3D graphics application performs a process called "tesselation", in which all of the objects in the 3D world are converted into collections of simple polygons (usually triangles). Second, the vast majority of today's high-performance 3D graphics applications use a programming interface called OpenGL©, which allows the application to pass requests to graphics accelerator boards in a well-defined format.

The problem is that OpenGL was conceived with flat-screen displays in mind. In the case of the VisionDome, if you want to display a straight line, then that line has to be curved so that it appears straight on the curved screen (if you see what I mean). In order to handle this, Alternate Realities' software takes the OpenGL calls and re-tesselates everything on the fly (for each frame) so that it can correct for the curvature of the screen.

The overall effect is one of total immersion — I now know what it feels like to fly through a 3D molecule, and that's not something you expect to hear yourself saying too often! ☐

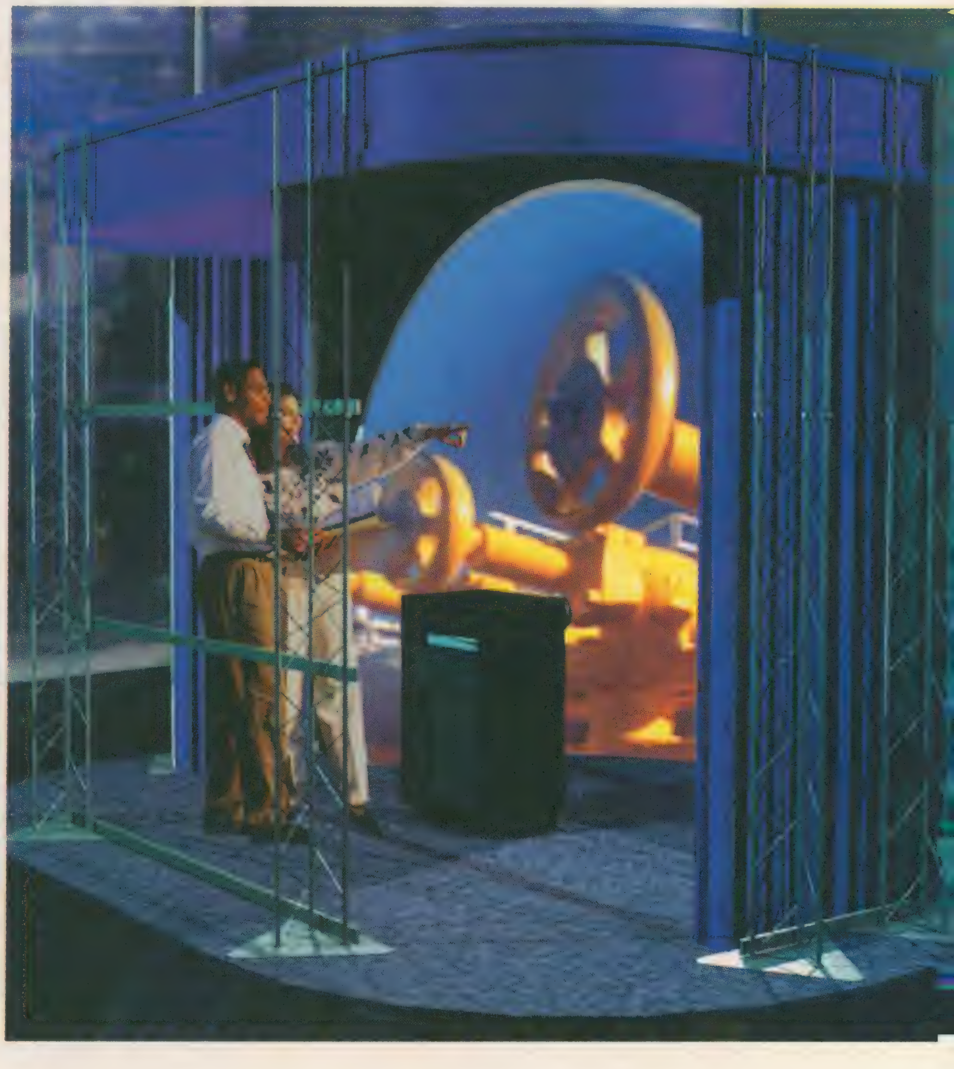
3D GRAPHICS

If you want to know more about 3D graphics, including the meaning behind terms like tesselation, OpenGL, textures, and suchlike, then we would recommend the easy-to-understand introductory book *Graphics Supercomputing on Windows NT*.

This book commences by introducing 2D bitmapped and vector graphics, and then moves on to discuss 3D graphics concepts. These introductions are easy to understand and set the scene for what is to come. As you will discover, the main portion of the book is occupied by an extensive colour illustrated glossary, which covers everything from the different schemes for representing colour and translucency, to lighting, shading, texturing, and rendering.

You can download a sample chapter of this book (the chapter on 3D Graphics) by visiting the *EPE Online* Web site at **www.epemag.com** and strolling into the *Library*. If you like what you see, you can purchase the full printed book directly from the *EPE Online Store*.

Fig.10. The VisionDome really immerses you in the scene (Courtesy Alternative Realities Corp.)



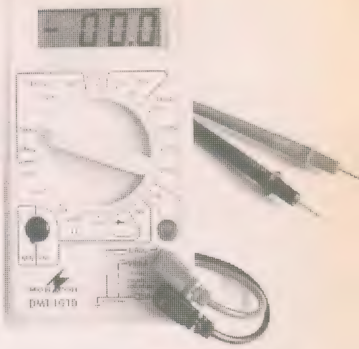
READOUT

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

WIN A DIGITAL MULTIMETER

The DMT-1010 is a 3½ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

Every month we will give a DMT-1010 Digital Multimeter to the author of the best *Readout* letter.



✭ LETTER OF THE MONTH ✭

APPLE iMAC

Dear EPE,

I was delighted to see two items in the January 1999 issue relating to the Apple iMac computer, but I think that you were very unfair with your comments in both pieces. The *Innovations* article on page 15 is very misleading on several points: it implies that suitable peripherals are difficult to find – this is simply not the case. The iMac's USB ports are standard PC connectors. A whole range of low cost devices including scanners, printers and serial adapters were available to buy in the UK when the iMac was launched in September, and many new products have come onto the market since then, including external disk drives.

The iMac does have an expansion slot, although its use is limited, but since the iMac comes with an ATI Rage Pro Turbo graphics controller and 6MB of video RAM, SRS sound, 100Mps Ethernet and 56K modem built in, it is hard to imagine what a home user would need to add. The cost of RAM for the iMac is no different to any other modern PC and the price varies greatly – at the moment (Dec '98) most iMac suppliers are including free 96MB RAM upgrades. Many people have criticised Apple for not including a floppy drive, but this does make sense if you consider that most people buy an additional zip or superdisk drive for their PC anyway, leaving the floppy redundant.

I do not understand why you have decided to quote the start-up time as your only measure of how fast the iMac is. Since when has this been a useful measure of a computer's capability? In use, the iMac is blisteringly fast – the combination of the super fast Power PC processor with its highly efficient Cache memory and accelerated video hardware mean the iMac is only marginally slower than Apple's top of the range systems costing three times as much – truly amazing for a home computer.

The *Net Work* article on page 69 does provide a far more rounded piece on the iMac, until Alan Winstanley chooses not to recommend the machine on grounds that I feel are unjustified. It is true that Apple Macs are rarely seen in the high street – but this means that there is a thriving mail order community instead. I see no reason why a "technically inexperienced" iMac owner should have difficulty buying mail order. I have yet to gain any benefit from sales staff at Dixons or PC-World when buying computer equipment. It seems far better to talk to a real expert in a mail order company over the telephone.

With regard to the issue of IBM PC software compatibility, this is no longer a serious problem for Apple users. Virtually all of the major software titles (Microsoft Word and Excel, Adobe Photoshop, etc) are available for both Mac and PC, and they use identical file formats – files saved on the Mac can be opened on the PC and vice-versa.

Easy Open file translation software, often bundled with Apple computers performs automatic translation of documents when the correct application isn't available – far more flexible than straight compatibility. I am not exaggerating by saying that in many cases, Apple computers are more compatible with PCs than PCs are. I am regularly using my Macintosh computer to unzip, translate and convert PC files for my colleagues to use on their PCs.

For software titles not available for the Mac, a number of excellent and very realistically priced software emulators are available that will run any Windows application. The astonishing speed of the iMac means it is quite capable enough to run Windows 98 at Pentium speeds. I currently use Virtual PC to run Windows 95 and the Microchip MPLAB software and program PIC microcontrollers without any problems on my Mac, a model far less well specified than the iMac.

The issue of IBM compatibility is not nearly as serious as you suggest. Apple's Macintosh computers (including the iMac) run MacOS, currently at version 8.5, which is almost universally acclaimed as the best personal computer operating system available. It is brilliantly designed from the ground up to provide fast, easy computing. The MacOS and applications that run on it really are a joy to use – a far cry from the problems of Windows 3.1, 95 and 98. Apple computer hardware is also exceedingly well built – there are many ten-year old Macintosh systems in use today.

If you want an indication of just how good Apple Computers and the Macintosh MacOS operating system is, consider this: despite the fact that Mac users are in a minority among Windows users, the fact that Mac hardware and software often isn't available on the high-street, and the fact that Apple computers have always previously been more expensive than Windows systems, Apple is still one of the largest computer companies in the world, second only to companies like Dell and Compaq in terms of numbers of computers sold, but always on top and winning awards with the fastest machines, and newest and most innovative technologies. It is fantastic that Apple is able to produce the iMac, a fully specified computer at a home computer price.

I find it sad that such a brilliant piece of engineering is knocked back largely on the basis that it isn't directly compatible with the majority of PCs. There are millions of people in the world who know that there are problems with Windows 95, millions having problems with Windows 98 – so why are people so keen to stick with something so universally known to perform so poorly? With the iMac, Apple has at last produced a very credible, affordable alternative to Windows, and this should be applauded.

PS. I am a product designer/electronic engineer who uses both Macs and IBM-PCs every day, and I don't work for Apple!

Roger Coleman, via the Net

Thanks for an extremely interesting and different view point of the iMac. Editorially we try to be impartial and the views expressed by contributors are entirely their own.

WEBBED TRACKS

Dear EPE,

Now that the technology to publish electronically has been proven with the advent of *EPE Online*, it would be of great help for those producing p.c.b.s. at home to be able to print directly from a downloaded image of a p.c.b. track layout onto a transparency.

I also note that *EPE* does not have the hang-ups which some of the competitive electronics magazines have with respect to the protection of source code, and this is gratefully acknowledged. With the increasing number of hobby electronics projects being based on some form of microcontroller or other, protection of the code would seriously impact the constructor's ability to understand the operation of the unit.

Martin Shipley, via the Net

There are a number of problems associated with downloading p.c.b. images from the Web. Although most of the p.c.b. track images have been produced by authors who use p.c.b. CAD packages, the great variety of such packages available prevents us from making direct use of authors' electronically generated images (except in vary rare cases). Generally speaking, we scan double-size paper printouts of the p.c.b. tracks into our system as Corel Draw images.

Whilst we have full control over the size of the images that are subsequently output as those you see on the ordinary printed pages of the magazine, we have no control over the same images when they are electronically put on the Web for downloading as part of EPE Online. *Consequently, Web users cannot be assured that the p.c.b. images they print are the correct size, we are, however, working on this problem.*

Regarding source codes, we have long maintained that readers have as much right to these as they have to the circuits and p.c.b. layouts. It is part of our conditions of article acceptance that the source codes are available for the use of all readers without restriction.

WHAT'S IN A NAME?

Dear EPE,

It is sad to see the end of *Electronics Today International* as a separate entity, but on the subject of what the combined magazine should be called (*Editorial* Feb '99): I felt the original publishers made a mistake when they chose to shorten it to *ETI* some years ago. It could stand for almost anything – English Tourist Information, maybe. If electronics magazines are trying to attract new readers, what better than to have the word *Electronics* beaming out amongst the many publications on the newsagents' shelves?

The word *Practical* should also be dropped. It was a commendable tribute to an old rival, but *Everyday Practical Electronics* never did roll off the tongue.

Then we have a possible conflict – *Everyday or Today* – perhaps not. *International* is quite relevant, as you are available worldwide.

So here is my title suggestion – *Everyday Electronics International* (NOT *EEI* please!).

K. G. Mitchell, Loughton, Essex

Thanks for the observations – we'll stay silent on this subject for the moment, just letting readers have their say – Carry On Commenting!

COMPRESSORS

Dear EPE,

Having used limiters and compressors professionally in the 60s and 70s, as well as building many gain control circuits as a hobby, I cannot totally agree with Robert Penfold's analysis of the causes of disturbing changes in volume on TV.

Any programme (and I draw no distinction between a two hour drama production or a 30 second commercial) will be produced with consistent sound levels. Possible exceptions to this are News bulletins where material will arrive during transmission and thus cannot sometimes be checked for sound level as thoroughly as would be desirable. Although some viewers may be upset by the sound levels, it is impossible to cater for the quality delivered by all TV sets. There is a world of difference between the sound of a decent set with a forward facing loudspeaker and a small "portable" set with a sideways facing loudspeaker pointing at heavy curtains which soak up most of the frequencies that provide intelligibility.

Within a programme, the long established technique of gradually reducing the level over some 10 to 20 seconds prior to a climax will give impact without over-modulation, but it would be impossible to do this before commercial breaks without lengthy rehearsal and in today's climate it is unlikely that any broadcaster would have the resources to provide the staff to do this.

The problem is that commercial breaks as well as the trails and promos aired between programmes on BBC1 and BBC2 have been produced as standalone "programmes" and considerable time will have been spent to ensure that everything looks and sounds right. I have come across before the belief that the sound levels of programmes are reduced to make the commercials stand out. This is a very doubtful premise since advertisers are aware of their target audience and are unlikely to wish to alienate them, nor does it make sense for the broadcaster to do this since a reduction in level of say 6dB with respect to the level of the commercial is the same as having the sound transmitter on half power except for a few minutes in every twenty which will impair the signal-to-noise ratio of analogue transmissions and possibly make quantizing noise apparent on digital transmissions.

So why do some commercials sound so loud? It is because they have been compressed! There are many combinations of attack and release times, compression ratios and thresholds that can be used making it more of an art than a science. A favourite technique of mine that did not always work was to cut the bass, compress quite heavily and then boost the bass by the same amount that it had been cut; if it didn't work it sounded dreadful but there was no way of predicting this. (This was in the days before manufacturers routinely provided EQ insert points in the side chain).

Compression is not necessarily used to ensure viewers attention will be grabbed but mainly to get the message across in an impeccable style given the content and the short duration, which means there is no time to implement the techniques used in say drama productions and thus the use of compressors is the only way to achieve the desired result.

In some respects this is no different to a Top 40 single. The producer of this is not concerned what radio station it is played on; it is simply a standalone product that satisfies the producer and the artist and if they get it right it will sell. Thirty years ago, for example, broadcasters employed sound staff to ensure that sound levels were seamless. I suspect that today's solution is to simply have a peak limiter in circuit or if there is an operator in charge then that person is simply looking at a meter and not listening to the output.

That said, I'm certain that Robert Penfold's circuit will do what he says it does and better than many circuits I have seen and tried, except that I wouldn't call it a Compressor, which is generally taken to mean a device that reduces the dynamic range and thus increases the average sound level and makes things sound louder. A more accurate name, given the attack and release times, would be an Automatic Volume Control.

Where I will disagree is with the suggestion to build two boards for stereo. This will not be satisfactory. Suppose a signal in the left channel is high enough to cause gain reduction. The level in the LH channel will be reduced and a central image will be pulled to the right as no gain reduction has occurred in the RH channel.

Depending on which channel causes gain reduction, a central image will swing about the centre in a very disturbing way. What must be done to ensure stability of the central image is to ensure identical gain reduction in both channels regardless of which channel causes the reduction.

A simple way of doing this is to combine the outputs of IC3 with a virtual earth mixer and feed this into a single side chain with the output of the side chain feeding both VCAs. As there is another *n*-channel MOSFET in a 4007 and a TL072 costs the same as a TL071, a stereo version could be built for only a little more than a mono version.

Barry Taylor, via the Net

Robert replies:

I found Barry's letter very interesting but do not think that his explanation of things is that much different to my own. I suggested that the apparent volume could be (and probably is) made greater by using a high average level, and this is something that is achieved using compression.

Some of the over-loud advertisements sound to me as though there has been some doctoring of the frequency response, but I obviously have no way of proving this. Whatever the cause, there are certainly large numbers of people who have problems with the sound for one reason or another. Hence this project, which was requested by readers.

I normally find that separate processing of stereo channels gives the best results, but in this case I think Barry is probably right, and that controlling the two channels in unison would give slightly better results, maintaining correct stereo balance.

Robert Penfold

D.I.Y. ONLY

Dear EPE,

Could you help with your *PIC Tutorial* as I now seem to be a bit stuck. I am having a problem trying to understand some of the exercises. Could you please send me the answers to all the exercises so that I can compare my answers with them.

Roy Chaplin, via the Net

It's not often I refuse to help, but I am doing so on this one – sorry to disappoint you! It is not in the interests of those studying the PIC Tutorial *that they should be given answers to the exercises. The exercises are not of the same nature as, for example, problems in mathematical text books, where often there is only one correct answer.*

The intention of the exercises is to get readers thinking for themselves about how to deal with the programming situations presented. In many instances there are several ways in which programming solutions can be achieved. There are sufficient discussions and examples within the tutorials for readers to apply intelligence and logical thinking about how the programming commands that are available can be used to create a program routine that achieves the suggested objective. After all, there are not a lot of commands whose function you have to learn.

Readers who are capable of applying concentration on a logical problem should not really find the exercises difficult. For me to provide answers would not really get people thinking for themselves. In a real-life situation, you won't be able to keep on asking others how to solve programming problems that you need to overcome.

In your hobby activities, for example, it's you who have invented the design for which you want a PIC (or other processor) to provide control. If you keep asking others to write your programs, where's the pleasure or sense of achievement for you in having thought up the idea? It will have ceased to be your creation.

A more severe situation will occur if you are writing a program as part of your job requirement. If programmers cannot provide programming solutions, they will cease to be of value to their employers – need I say more?

As a general tip with a programming problem, if you cannot solve it immediately, take it step by step, experimenting at each step if necessary, and just keep on until you do solve it. It could be that the approach you first thought was the correct one may turn out to be based on a wrong assumption. Try alternative ways of achieving the desired end result. It's the way I learned to program – I assume it is logical to think that others involved in programming have a similar attitude.

But at the end of the day, it is worth recognising that not everyone is capable of seeing the world in programming terms. And there is no shame in being such a person. We all have our talents, and there are many things which some people can do successfully that others cannot, the latter having their own strong points unassailable by the former.

However, if you believe you are logical enough in your thinking, you probably are capable of programming – so keep at it and you'll get there!

Am I right in expecting to receive critical letters as a result of this reply? (Yes, I know we at EPE *set out to educate and encourage people in electronics – but how far is hand-holding justified or desirable?) Yell at me if you wish!*

IEE REGULATIONS

Dear EPE,

I am afraid that Bob McMillan has not consulted his IEE Regulations recently (*Readout* Jan '99). In the 16th Edition there are three earthing systems shown (TN-S, TT and TN-C-S) and it states that the classification of the system will depend upon the distribution system and not upon the customer's installation.

As a retired electrician (my career covers Contracting, Installation and Maintenance at the National Coal Board), I recommend that readers use mains testers to check their supply integrity – I have used a commercial version for many years and found them useful for quick checks, and have never found them hazardous.

L. G. Sutton,
Burton-on-Trent, Staffs

The above is just part of a much lengthier letter from Mr Sutton, who also kindly sent illustrated extracts from the IEE Regs from which it is obvious that the situation is far more complicated than the discussion has hitherto revealed. It is a subject (as we have said on other occasions) that we shall return to in greater depth.

WICKETLY CHUFFED

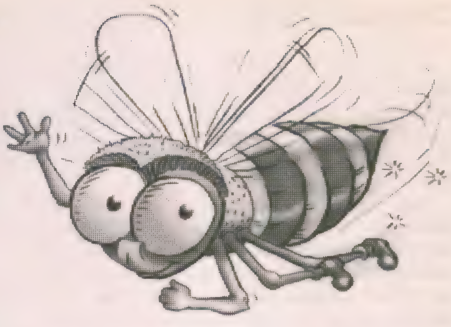
Dear EPE,

Thanks very much for making my letter *Letter of the Month* (Feb '99), I am very "chuffed" and I get a prize! Ya hoo!

And best of British luck in the one day cricket. I might be an Aussie but I still think Warne and Waugh should be tossed out . . . permanently.

Carle Wilde,
Acacia Ridge, Australia

In deference to our many overseas readers we are officially impartial to international conflicts! (Carl faxed these comments to us on 7 Jan '99 in response to us telling him of his letter's status.)



PhizzyB COMPUTERS

Part 5: Introducing the PhizzyBot: The D.C. Motor Controller

Clive "Max" Maxfield and Alvin Brown

WELCOME to the fifth instalment of our really unique and exciting electronics and computing project. This series of articles, as many of you are confirming, will be of interest to anyone who wants to know how computers perform their magic, because it uses a unique mix of hardware and software to explain how computers work in a fun and interesting way.

We now enter the second phase of the tale about our phantasmagorical little rascal, getting ready to drive the world (or at least, our buggy) buzzing with excitement – yes, folks the PhizzyBot robotic wheelie is fast approaching. You too can drive it, without needing to know too much about electronics (although you do need to know a bit about PCs).

GOOD grief – how time flies! It seems like only yesterday we were starting this PhizzyB series, and now we're poised to hit the ground running with a simple robot called the PhizzyBot.

In his PhizzyB constructional article elsewhere in this issue, that wanton warrior of electronics, Alan Winstanley, describes how to construct a simple controller device that will allow the PhizzyB to control two d.c. motors. These motors will, in turn, provide the PhizzyB with the ability to roam around the room, thereby turning it into the PhizzyBot.

WHAT'S IN STORE

For our part in this tutorial, we will start to consider some simple programs to first test the motors and later to control them more meaningfully. Please note that although this article concentrates on the real PhizzyB, all of the programs described herein can be run on the PhizzyB Simulator if you so desire.

Also note that this is where we start to use everything that we've done thus far (including the simple l.e.d. device from Part 2, the subroutine concepts we discussed in Part 3, the interrupt routine concepts and the interrupt-driven switch device from Part 4, and so forth).

The new programs we create here will form the basis for next month's article, in which Alan adds some collision detection capability to the PhizzyBot in the form of microswitches, while we will program the PhizzyBot to trundle around the room, taking evasive action whenever it bumps into anything. Later we'll be augmenting the PhizzyBot with some optical sensors, but all of that is in the future. For the nonce, we'll concentrate on testing and controlling the motors.

From Alan's article we know that we will be using the least-significant (LS) nibble (four bits) of one of our external output ports to drive the motor controller device (this leaves the most-significant (MS) nibble free to control more motors or other devices in the future). The bits used to control the motors are shown in Table 1.

In this context, the terms "Left" and "Right" refer to your perspective if you were to shrink yourself down to a height of six inches (15cm) and position yourself atop of the PhizzyBot looking towards its front end. If both motors are instructed to drive forwards, the entire PhizzyBot will trundle forwards (Fig.1a), and if both motors are driven in reverse, the PhizzyBot will go backwards (Fig.1b).

Table 1. The bits used to control the motors.

LEFT			RIGHT		
OP1	OP0		OP3	OP2	
0	0	–	0	0	–
0	1	Reverse	0	1	Reverse
1	0	Forward	1	0	Forward
1	1	–	1	1	–

If the left-hand motor is driving forward while the right-hand motor is driving in reverse, then the PhizzyBot will rotate in a clockwise direction (Fig.1c). Similarly, if the right-hand motor is driving forward while the left-hand motor is driving in reverse, then the PhizzyBot will rotate in an anticlockwise direction (Fig.1d).

Almost last, if the left-hand motor drives forward and the right hand motor is turned off, the PhizzyBot will turn to the right (Fig.1e). Similarly, if the right-hand motor drives forward and the left-hand motor is turned off, the PhizzyBot will turn to the left (Fig.1f).

SKELETON PROGRAM

OK, what we're going to do is to create a skeleton (framework) program, which we'll develop as we go along. Invoke your PhizzyB Simulator, activate the assembler, and enter the program shown in Listing 1.

As we see from the Constant Declarations section at the beginning of the program, we're assuming that the interrupt-driven switch device we created in Part 4 is connected to the input port at address $F012. Similarly, we're assuming that the 8-bit l.e.d. bargraph display we created in Part 2 is connected to the output port at address $F031, while our new motor controller board will be connected to the output port at address $F032. (We'll ignore the **DELCONST** constant declaration for the moment).

The rest of this skeleton program essentially consists of comments, plus a few temporary locations and data values at the end that we'll be using in the not-so-distant future.

EXPERIMENT 1

Testing the motors

Before you do anything else, save your skeleton program as **ddexp1.asm**. Now insert the following **GETCOMM** (get command) interrupt service routine between the "start and end of interrupt service routine" comments:

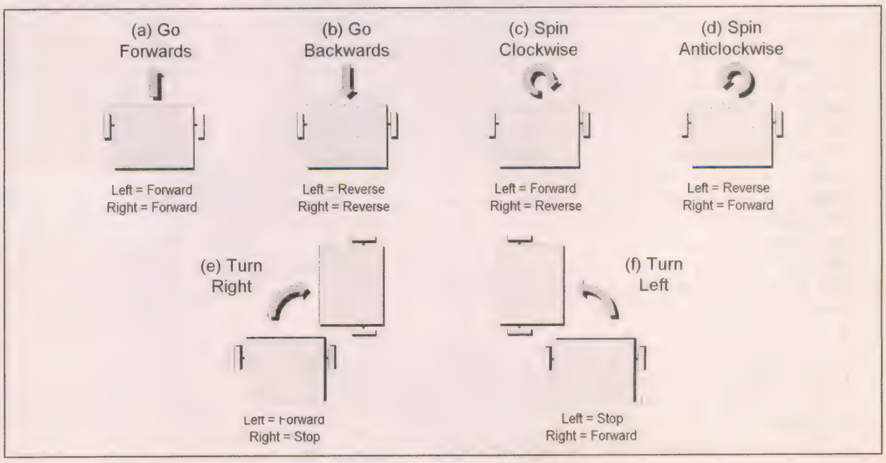


Fig.1. Using the motors to control the PhizzyBot*'s direction.*

Listing 1

```
### Start of Constant Declarations
SWITCHES: .EQU   $F012          # Switch input device
MGRAPH:   .EQU   $F030          # Motor bargraph display
TGRAPH:   .EQU   $F031          # Timer bargraph display
MCONTROL: .EQU   $F032          # Motor controller board
DELCONST: .EQU     20           # Delay constant value
### End of Constant Declarations

### Start of Main Program Initialization
          .ORG   $4000          # Set program origin
           BLDSP $4FFF          # Load stack pointer
### End of Main Program Initialization

### Start of Main Program Body
### End of Main Program Body

### Start of Interrupt Service Routines
### End of Interrupt Service Routines

### Start of Subroutines
### End of Subroutines

### Start of Temp Locations and Data Values
CNTFLAG:   .BYTE                # Flag (0=stop count)
TVALUE:    .BYTE                # Main timer temp value
COMMAND:   .BYTE $0A, $05, $02, $08, $06, $09, $00, $00
### End of Temp Locations and End of Program
           .END
```

```
GETCOMM:  LDA [SWITCHES]
          XOR $FF
          RTI
```

The first thing **GETCOMM** does is to read a value from the input port connected to the switches. From Part 4, we know that a closed switch (whichever one we've pressed) will present a logic 0 value to the port, while any open switches will present logic 1 values. But this is the opposite way round to the way we wish to see this data, so we next use an **XOR $FF** instruction to invert all of the 0s in the accumulator to 1s, and vice versa.

Finally, we execute an **RTI** (return from interrupt) instruction, which exits this routine and returns us to the main body of the program (with the value we read from the switches safely squirreled away in the accumulator).

Now insert the following statements between the "start and end of main program body" comments:

```
BLDIV       GETCOMM
            SETIM
MAINLOOP:   HALT
            STA [MGRAPH]
            STA [MCONTROL]
            JMP [MAINLOOP]
```

The first of these instructions loads the interrupt vector with the start address of our **GETCOMM** interrupt service routine. This is followed by a **SETIM** (set interrupt mask) instruction, which instructs the CPU to respond to future interrupts. (Interrupts, interrupt service routines, and the interrupt mask were introduced in Part 4.)

Next we use a **HALT** instruction, which will cause the CPU to stop everything and wait for an interrupt (or a reset) to occur. When an interrupt does occur, the CPU will jump to the **GETCOMM** routine, read a value from the switches, and return to the main body of the program.

As soon as we do return, we store the value in the accumulator to the 8-bit l.e.d. bargraph display at address $F030, and also to the motor controller connected to the output port at address $F032, then we jump back to the beginning of **MAINLOOP** and wait for a new interrupt to occur.

Assemble this program, download the resulting **ddexp1.ram** file to the PhizzyB, and set the program running. Now click switch S0 on the interrupt-driven switch device and observe the bit 0 l.e.d. on the $F030 bargraph display light up. Also observe that the left-hand motor starts to turn in its "reverse" direction. (Refer back to Table 1 at this time to remind yourself how the output bits relate to the motors.)

Now click switch S1 and observe bit 1 on the bargraph display light up and the left-hand motor start turning in its "forward" direction. Next click switch S2 and observe bit 2 on the bargraph light up and the right-hand motor start turning in its "reverse" direction. Now click switch S3 and observe bit 3 on the bargraph light up and the right-hand motor start turning in its "forward" direction.

Finally, click any of the switches S4 through S7 to stop both motors. Then reset the PhizzyB and proceed to the next experiment.

EXPERIMENT 2

More sophistication

The previous experiment served to prove that we can control the motors at a rudimentary level, but we really need to be a little more sophisticated. What we would like to do is to assign particular tasks to the different switches as shown in Table 2

For example, from Table 2 you will see that we want switch S4 to correspond to the command "Spin Clockwise". In order to do this, we need the left-hand motor to drive forwards (OP1 = 1 and OP0 = 0) and the right-hand motor to drive backwards (OP3 = 0 and OP2 = 1).

The hexadecimal digits associated with each of these commands are also shown in Table 2. If you now cast your attention to the data values associated with the label **COMMAND** at the end of our program, you'll see that these values correspond to those shown in Table 2 (Ah Ha! Much like my mother's custard . . . the plot thickens).

Save your modified program under the new name of **ddexp2.asm**, and then modify the **GETCOMM** routine so that it now looks like the one shown in Listing 2. As you see, our new **GETCOMM** routine is a little more sophisticated than our earlier version. First we use a **BLDX** instruction to load the index register with 0. Then we use an **LDA** to read a value from the switches and an **XOR** to invert that value into the form we prefer.

Listing 2

```
#== Start of "Get Command" Routine
GETCOMM:    BLDX   $0000          # Load index register = 0
            LDA    [SWITCHES]     # Read value on switches
            XOR    $FF            # Invert 0s to 1s etc.
GCLOOP:     RORC                  # Rotate right 1 bit
            JC     [GCRETURN]     # Jump if carry flag = 1
            INCX                  # Else increment X reg
            JMP    [GCLOOP]       # Jump back and repeat
GCRETURN:   LDA    [COMMAND,X]    # Get command byte
            RTI                   # Exit routine
#== End of "Get Command" Routine
```

Now we enter a loop starting at **GCLOOP**, in which we rotate the accumulator one bit to the right, which causes the bit that "falls off the end" to be copied into the Carry flag. If we see a 1 in the Carry flag we jump to the **GCRETURN** label, otherwise we increment the index register and jump back to **GCLOOP**.

Thus, when we actually reach the **GCRETURN** label, the value in the index register corresponds to the number of the switch that we pressed (that is, for switch S0 the index register contains 0, for switch S1 the index register contains 1, and so forth).

The cunning part of all this occurs at **GCRETURN**, in which we use an **LDA** to load the accumulator using the indexed

Table 2: Associating commands with the switches.

Switch	Action	Output Bits OP3	OP2	OP1	OP0	Hex Value
0	Go forward	1	0	1	0	A
1	Go backwards	0	1	0	1	5
2	Turn right	0	0	1	0	2
3	Turn left	1	0	0	0	8
4	Spin clockwise	0	1	1	0	6
5	Spin anti-clockwise	1	0	0	1	9
6	Stop	0	0	0	0	0
7	Stop	0	0	0	0	0

Listing 3

```
#== Start of "Main Timer" Routine
TIMER:      STA   [TVALUE]     # Store original count
            STA   [CNTFLAG]    # Set flag to non-zero
TLOOPA:     JSR   [ONETENTH]   # Call 1/10 Sec loop
            LDA   [CNTFLAG]    # Load flag
            JZ    [TRETURN]    # Jump if flag=0
            LDA   [TVALUE]     # Load count value
            DECA               # Decrement it
            STA   [TVALUE]     # Store it
            STA   [TGRAPH]     # Store it to LEDs
            JNZ   [TLOOPA]     # Loop again if !=0
TRETURN:    RTS                # Exit subroutine
#== End of "Main Timer" Routine

#== Start of "1/10 Second Sub-Timer" Routine
ONETENTH:   LDA    DELCONST    # Load count value
OTLOOPA:    DECA               # Decrement it
            JNZ   [OTLOOPA]    # Loop again if !=0
OTRETURN:   RTS                # Exit subroutine
#== End of "1/10 Second Sub-Timer" Routine
```

addressing mode. That is, the statement **LDA [COMMAND,X]** instructs the CPU to "load the accumulator with the data in the location whose address is given by adding the address of the label **COMMAND** with the contents of the index register". (Phew!)

Remember that the PhizzyB's addressing modes are discussed in Appendix A of *The Official Bebopuler Microprocessor Databook* (and also that this Appendix is provided *free* with your PhizzyB Simulator – see the simulator's online help for more details).

The end result is that if you click switch S0, this instruction will load the accumulator with the data value $0A (stored at the address of **COMMAND** + index register = 0). If you click switch S1, we'll load the accumulator with the data value $05 (stored at the address of **COMMAND** + index register = 1), and so forth.

Assemble this program, download the resulting **ddexp2.ram** file to the PhizzyB, and set the program running. Now click switch S0 on the interrupt-driven switch device and observe bits 3 and 1 on the $F030 bargraph display light up. Also observe that both the left and right motors start to go in their forward direction.

Refer back to Table 2 to remind yourself how the switches relate to the different commands, then experiment by pressing switches S0 through S5 to confirm that everything works as expected.

Finally, click switch S6 or S7 to stop both motors, then reset the PhizzyB and proceed to the next experiment.

EXPERIMENT 3

Creating a timing routine

One thing we're going to require in the future is the ability to perform actions for specific amounts of time. For example, "go forward for 5 seconds, turn right, pause for 3.5 seconds, go forward for 2 seconds", and so forth.

Before we leap into action, it will be advantageous to our future selves if we spend a little time thinking about the "usage model" for this routine (that is, how are we going to call it from other parts of the program).

For example, it would be a pain if we created a timing loop that had to be executed some weird number of times, such as "214 cycles round the loop equals one second". In this case, whenever we wanted a specific delay, we'd have to whip out a pencil and start performing calculations (e.g. a delay of 2.5 seconds = 2.5 × 214 = 535 cycles *. . . arrgggh*).

A more preferable solution for our purposes would be to be able to instruct the routine to delay for a specific number of 1/10ths of a second. With this in mind, save your previous program as **ddexp3.asm** and then enter the two subroutines shown in Listing 3 between the "start and end of subroutines" comments.

First let's consider the **ONETENTH** subroutine, which is the one we're going to use to create a delay of 1/10th of a second. We commence this subroutine by loading the accumulator with the value represented by the constant label **DELCONST** (delay constant), which we originally declared in the Delay Constants section at the beginning of the program.

Next we start a loop in which we decrement the value in the accumulator and then test it with a **JNZ** (jump if not zero) instruction. This means that we keep on looping around until the accumulator contains zero, at which point we exit from the subroutine. So all we have to do is to assign an appropriate value to **DELCONST**, such that this routine does indeed take 1/10th of a second to count the accumulator down to zero.

Now turn your attention to the main **TIMER** subroutine, whose delay value (specified as an integer number of 1/10ths of a second) is already present in the accumulator when we call the routine (we'll see how this happens in a moment).

The first thing we do when we enter this routine is to save the value in the accumulator to our temporary location **TVALUE** (which we reserved at the end of the program). Next we store the same value to the **CNTFLAG** location, on the basis that we're going to use any non-zero value in this location to indicate that the count should proceed.

Now we enter a loop that commences at label **TLOOPA**, and the first thing we do is to call our **ONETENTH** subroutine (this is an example of "nested subroutines", in which one routine calls another).

As soon as we return from **ONETENTH**, we load the accumulator with the value in **CNTFLAG**. If the value of this flag has been mysteriously set to zero we will exit the **TIMER** routine, otherwise the count will continue. Next month we will investigate how we can use an interrupt to modify the **CNTFLAG** value and terminate the count. The reason we've included this test here is that adding instructions at a later date will modify (i.e. mess up) any delays generated by our routines.

Next we re-load the count value from our **TVALUE** temporary location, decrement it, store it away again, and also store it to **TGRAPH**, which is the address of the output port driving the external 8-bit l.e.d. display. Thus, this display will be updated with a new value every 1/10th of a second.

Next we test the count value to see if it is zero. If so we'll exit this routine and return to the main program, otherwise we'll jump back to the beginning of the loop at **TLOOPA** and do the whole thing again.

Now we need to create a very simple interrupt service routine. Scroll through the program to the "start of interrupt service routines" comment and insert the following statement:

```
WAITIRQ:    RTI
```

As we said, this really is a very simple routine. In fact all it does (when it's called) is to return, but that's enough for our purposes as we'll see.

Last but not least, we need to modify the instructions between the "start and end of main program body" comments such that they now read as follows:

```
BLDIV       WAITIRQ
            SETIM
MAINLOOP:   HALT
            LDA 250
            JSR [TIMER]
            JMP [MAINLOOP]
```

This is very similar to what we did before. In this case, the **BLDIV** instruction loads the interrupt vector with the start address of our new **WAITIRQ** interrupt service routine. This is followed by a **SETIM** (set interrupt mask) instruction, which instructs the CPU to respond to future interrupts.

Next we use a **HALT** instruction, which will cause the CPU to stop everything and wait for an interrupt (or a reset) to occur. When an interrupt does occur, the CPU will jump to the **WAITIRQ** routine, which, as we just discussed, does nothing except return.

As soon as we do return, we load the accumulator with a value of 250 (which we understand to mean 250 × 1/10th of a second = 25 seconds). Then we call our timer routine which we hope will count down the appropriate delay, then we jump back to the beginning of **MAINLOOP** and wait for a new interrupt to occur.

TIMER CALIBRATING

Assemble this program to generate the corresponding **ddexp3.ram** file, download the program to the PhizzyB, and set it running.

Now place your wristwatch on the table next to your PhizzyB, wait for the second hand to reach the top, and click the PhizzyB's IRQ (interrupt request) button. Observe that the 8-bit l.e.d. bargraph display connected to the output port at address

$F031 starts to count down from binary 11111010 to 00000000 (from 250 to 0 in decimal). Note the elapsed time in seconds as soon as all of the l.e.d.s are extinguished.

Press the IRQ button again to re-time the delay. Repeat this several times and average the delay values to try to compensate for human error. This average should turn out to be approximately 38 seconds, which is a bit longer than the 25 seconds we require.

Reset the PhizzyB, return to the assembler and scroll to the **DELCONST** label at the top of the program, and modify the value assigned to this label to 5. Re-assemble the program and re-run the above tests. This time the resulting average delay should be around 15 seconds, which is somewhat shorter than the 25 seconds we're looking for.

Experiment with different **DELCONST** values until you find the one that gives you a total delay as close to 25 seconds as possible (a **DELCONST** value of 12 should be as close as makes no difference – dang, perhaps we should have mentioned that before, but then you wouldn't have had so much fun).

Once you've finished calibrating the timer, reset the PhizzyB and proceed to the final experiment.

EXPERIMENT 4

Honing your motor skills

Now we're really humming along, because we've already got everything we need to proceed (no more routines to create). In fact all we've got to do is to ''glue'' our existing routines together in a slightly different way. So save your program as **ddexp4.asm** and then modify the main body of the program as shown in Listing 4.

Listing 4

```
### Start of Main Program Body
            BLDIV  GETCOMM       # Load interrupt vector
MAINLOOP:   SETIM                # Enable interrupts
            HALT                 # Wait for an interrupt
            CLRIM                # Disable interrupts
            STA    [MGRAPH]      # Store command to LEDS
            STA    [MCONTROL]    # Store to motor controller
            LDA     50           # Load ACC with 5 secs
            JSR    [TIMER]       # Call timer routine
            LDA    $00           # Load ACC with 0
            STA    [MGRAPH]      # Store "motors off" to LEDS
            STA    [MCONTROL]    # Store to motor controller
            JMP    [MAINLOOP]    # Wait for a new command
### End of Main Program Body
```

As we said, we've seen all of this before in one way or another, so perhaps the best thing to do is to run the program and see what happens. Assemble the new program to generate the corresponding **ddexp4.ram** file, download this program to the PhizzyB, and set it running.

Now click switch S0 and observe that the 8-bit l.e.d. at output port $F030 displays a value of 00001010 and both of the motors start up in their ''forward'' direction (just like they did in Experiment 2). Also observe that the 8-bit l.e.d. at output port $F031 starts to count down from 00110010 to 00000000 (from 50 to 0 in decimal), which equates to a five second delay. As soon as the timer counts down to zero, our new ''main body'' turns both of the motors off.

Similarly, clicking any of the switches S0 to S5 will result in the appropriate motors (as specified in Table 2) running for five seconds before stopping. Pretty cool eh? Next month we'll extend these routines to provide the PhizzyBot with some rudimentary intelligence, but feel free to experiment on your own until then.

FURTHER EXPERIMENTS

On the off-chance that you're desperate for something to do, you could try exchanging the addresses associated with the **MGRAPH** and **TGRAPH** labels (such that the timer is now displayed on the l.e.d.s as address $F030 while the state of the motors is displayed on the l.e.d.s as address $F031).

Next, unplug the l.e.d. device from the output port at address $F031, replace it with the liquid crystal display (l.c.d.) module from Part 3, and modify the program so as to display appropriate messages on the l.c.d., along the lines of ''Turning Left'', ''Going Forward'', and suchlike. (This should keep you busy until we meet again in Part 6.)

PhizzyB COMPETITION 1 – The Results

AND THE QUESTION WAS ... ?

Consider the simple program shown in Listing 1. As we see, this program just loops around reading values from the 8-bit switch (connected to the input port at address $F010) and writing these values directly to the 8-bit l.e.d. (connected to the output port at address $F030).

Using the table provided in Appendix A of *The Official Beboputer Microprocessor Databook*, we can determine that this program uses nine bytes of the PhizzyB's memory (note that this Appendix is provided with the PhizzyB Simulator – check the simulator's online help for more details).

Remember that a switch = down = off = logic 0, while a switch = up = on = logic 1. Also an unlit l.e.d. = off = logic 0, while a lit l.e.d. = on = logic 1. Thus, using this program, a pattern of 00110101 on the switches will, not surprisingly, result in a pattern of 00110101 on the l.e.d.s.

As you may recall, the competition described in PhizzyB Part 3 tutorial (*EPE* Jan '99) required you to perform a very similar task to that performed by the program shown in Listing 1. However, for the purposes of the competition, we requested that you ''flip'' the value from the switches, such that the state of the most-significant (MS) left-most switch is displayed on the least-significant (LS) right-most l.e.d., and vice versa, and so forth for the other bits. For example, a pattern of 00110101 on the switches should result in a pattern of 10101100 on the l.e.d.s.

Listing 1

```
INPORT:    .EQU $F010       # Constant label        =  0 bytes
OUTPORT:   .EQU $F030       # Constant label        =  0 bytes
                            #
           .ORG $4000       # Define start of prog =  0 bytes
LOOP:       LDA [INPORT]    # Load ACC              =  3 bytes
            STA [OUTPORT]   # Store ACC             =  3 bytes
            JMP [LOOP]      # Jump back and loop    =  3 bytes
                            #                       ----------
           .END             # End prog,      Total =  9 bytes
```

Furthermore, the judging criterion for this competition was that your program should use the smallest possible number of bytes in the PhizzyB's memory.

FIRST-PASS SOLUTION

Before we look at the winning entry, it will be advantageous to peruse and ponder some alternative solutions created by the authors to see how one might set about tackling a problem such as this.

In this particular case, the core strategy appeared to be relatively obvious. We know that using a **SHL** (shift left) instruction to shift the contents of the accumulator one bit to the left will cause the MS bit (the bit that ''falls off the end'') to be copied into the carry flag. Similarly, we

Table 1.

Original value C	Original value 7 6 5 4 3 2 1 0	Flipped value C	Flipped value 7 6 5 4 3 2 1 0	
X	0 0 1 1 0 1 0 1	X	X X X X X X X X	Situation after reading switches
0 <-	0 1 1 0 1 0 1 X	0	X X X X X X X X	Shift original value 1 bit left
0	0 1 1 0 1 0 1 X	0 ->	0 X X X X X X X	Rotate new value 1 bit right
0 <-	1 1 0 1 0 1 X X	0	0 X X X X X X X	Shift original value 1 bit left
0	1 1 0 1 0 1 X X	0 ->	0 0 X X X X X X	Rotate new value 1 bit right
1 <-	1 0 1 0 1 X X X	1	0 0 X X X X X X	Shift original value 1 bit left
1	1 0 1 0 1 X X X	1 ->	1 0 0 X X X X X	Rotate new value 1 bit right
	:		:	
	etc.		etc.	

Listing 2

```
INPORT:   .EQU    $F010       # Constant label        =  0 bytes
OUTPORT:  .EQU    $F030       # Constant label        =  0 bytes
                              #
          .ORG    $4000       # Define start of prog =  0 bytes
OLOOP:     BLDX    8          # Load index register   =  3 bytes
           LDA    [INPORT]    # Load ACC              =  3 bytes
           STA    [OLDVAL]    # Store ACC to temp     =  3 bytes
ILOOP:     LDA    [OLDVAL]    # Reload OLDVAL         =  3 bytes
           SHL                # Shift ACC left 1 bit =  1 byte
           STA    [OLDVAL]    # Store ACC in OLDVAL   =  3 bytes
           LDA    [NEWVAL]    # Load ACC with NEWVAL =  3 bytes
           RORC               # Rotate ACC right      =  1 bytes
           STA    [NEWVAL]    # Store ACC on NEWVAL   =  3 bytes
           DECX               # Decrement index reg   =  1 byte
           JNZ    [ILOOP]     # If !0 jump to ILOOP   =  3 bytes
           STA    [OUTPORT]   # Else ACC -> LEDs      =  3 bytes
           JMP    [OLOOP]     # Do it all again       =  3 bytes
                              #
OLDVAL:   .BYTE               # Temp location         =  1 byte (data)
NEWVAL:   .BYTE               # Temp location         =  1 byte (data)
                              #                          ----------
          .END                # End prog,      Total = 35 bytes
```

know that using an **RORC** (rotate right through carry) instruction to rotate the accumulator one bit to the right will copy the contents of the carry flag into the MS bit of the accumulator.

This means that if we loop around shifting the original value to the left and rotating the new value to the right, we'll end up "flipping" the old value into the new value. For example, consider the sequence shown in Table 1 (C = carry flag, X = don't know/care).

Of course there are many other ways in which we could achieve the same result, but this technique seems to offer one of the more efficient solutions, so let's consider a first-pass implementation of this approach as shown in Listing 2.

At the beginning of the program (**OLOOP** = "outer loop") we use a **BLDX** (big load index register) instruction to load the index register with the number of times we intend to go around the **ILOOP** (inner loop). Next we load a value from the switches and store it to a temporary location called **OLDVAL**.

Now we enter our inner loop, in which we shift the old value to the left and rotate the new value to the right. We do this eight times using the index register as a counter and decrementing the index register each time we go around the loop. As soon as the index register contains zero we know that we've finished, so we store the new value to the 8-bit l.e.d.s and jump back to the beginning of the program to read a new value from the switches and start all over again.

As we see, our first-pass solution requires 35 bytes. Hmmm, can we do any better than this?

USING THE STACK

As we know, the task is to create a solution that uses the smallest number of bytes. One point to remember is that loads and stores using the absolute addressing mode each require three bytes. This can be quite expensive as a percentage of the total program, so it's worth trying to cut down on these instructions as much as possible. For example, consider the program shown in Listing 3 (the differences to our previous attempt are highlighted in bold).

In this case we've decided to make use of the stack, because we can use **PUSHA** (push accumulator onto the stack) and **POPA** (pop accumulator from the stack) instructions to store values on and retrieve values from the stack, and these instructions each only require a single byte.

Thus, we can discard our **OLDVAL** temporary location, which saves us one byte. Unfortunately, we need to add a **BLDSP** (big load stack pointer) instruction, which costs us three bytes. However, once we've done this we can replace two **STA** (store accumulator) instructions (2 × 3 = 6 bytes) with two **PUSHA** instructions (2 × 1 = 2 bytes), which saves us four bytes. Also, we can replace an **LDA** (load accumulator) instruction (three bytes) with a **POPA** instruction (one byte), which saves us a further two bytes.

So the end result is that we have to add three bytes (from the **BLDSP**), but we save seven bytes from our finagling with the other instructions, which provides us with a total saving of four bytes, resulting in a program that is only 31 bytes long. Pretty good so far, but can anyone do better?

AND THE WINNER IS . . .

The winning solution was presented by **Don McBrien** who hails from Ireland. As you'll see, Don quickly spotted the "Shift-Left-Rotate-Right" strategy for solving this problem (although he used a "Rotate-Left-Rotate-Right" variation). However, Don enhanced his solution with a rather cunning technique, which involves a simple example of self-modifying code (the concept of self-modifying code is introduced in our book *Bebop BYTES Back – An Unconventional Guide to Computers*).

Before we look at Don's solution, consider what you would expect the following snippet of code to do:

```
GROK: LDA %00000000
      STA [OUTPORT]
```

You probably wouldn't be amazed to discover that running this program segment would cause a binary value of 00000000 to be written to the output port. But now consider the following:

```
      LDA %11111111
      STA [GROK+1]
GROK: LDA %00000000
      STA [OUTPORT]
```

Listing 3

```
INPORT:   .EQU    $F010       # Constant label        =  0 bytes
OUTPORT:  .EQU    $F030       # Constant label        =  0 bytes
                              #
          .ORG    $4000       # Define start of prog =  0 bytes
           BLDSP  $4FFF       # Load stack pointer    =  3 bytes
OLOOP:     BLDX    8          # Load index register   =  3 bytes
           LDA    [INPORT]    # Load ACC              =  3 bytes
           PUSHA              # Store ACC to stack    =  1 byte
ILOOP:     POPA               # Get ACC from stack    =  1 byte
           SHL                # Shift ACC left 1 bit =  1 byte
           PUSHA              # Store ACC to stack    =  1 byte
           LDA    [NEWVAL]    # Load ACC with NEWVAL =  3 bytes
           RORC               # Rotate ACC right      =  1 bytes
           STA    [NEWVAL]    # Store ACC on NEWVAL   =  3 bytes
           DECX               # Decrement index reg   =  1 byte
           JNZ    [ILOOP]     # If !0 jump to ILOOP   =  3 bytes
           STA    [OUTPORT]   # Else ACC -> LEDs      =  3 bytes
           JMP    [OLOOP]     # Do it all again       =  3 bytes
                              #
NEWVAL:    .BYTE              # Temp location         =  1 byte (data)
                              #                          ----------
           .END               # End prog,       Total = 31 bytes
```

Listing 4

```
INPORT:   .EQU   $F010       # Constant label     =  0 bytes
OUTPORT:  .EQU   $F030       # Constant label     =  0 bytes
                             #
          .ORG   $4000       # Set start of prog  =  0 bytes
INIT:      BLDX  8           # Set INDEX to 8     =  3 bytes
           LDA   [INPORT]    # Get input          =  3 bytes
           STA   [LOOP+1]    # Store input        =  3 bytes
                             #
LOOP:      LDA   $00         # Load FORWARD in ACC =  2 bytes
           ROLC              # Shift MS bit to C  =  1 byte
           STA   [LOOP+1]    # ... and store it   =  3 bytes
           LDA   $00         # Load REVERSE to ACC =  2 bytes
           RORC              # Shift C to LS-bit  =  1 byte
           STA   [LOOP+7]    # ... and store it   =  3 bytes
                             #
FINISH:    DECX              # Decrement INDEX    =  1 byte
           JNZ   [LOOP]      # Loop if not zero   =  3 bytes
           STA   [OUTPORT]   # Write REVERSE out  =  3 bytes
           JMP   [INIT]      # Jump back to start =  3 bytes
                             #                      ----------
          .END               # End prog,      Total = 31 bytes
```

In this case, the value written to the output port would actually be 11111111. The reason for this is quite simple, but it does require a little "lateral thinking" to get the hang of it. Note the label **GROK**. The address the assembler associates with **GROK** is the address of the **LDA** opcode, so **GROK+1** will be the address of the operand (data) byte associated with this opcode.

When we first assemble this program, the assembler will cause a binary value of 00000000 to be loaded into the memory location at address **GROK+1**. However, when we actually run the program, the first **STA** instruction will overwrite the contents of location **GROK+1** with a value of 11111111. The second **LDA** will subsequently load this 11111111 value into the accumulator, and the second **STA** will store this value to the output port.

Now consider Don's solution as shown in Listing 4 (the lines highlighted in bold are the ones in which Don uses his self-modifying code).

As we see, this program has no subroutines, no temporary data locations, and no stack. In fact this really is a rather cunning approach. First, Don saves a byte for each temporary location he doesn't use. But more importantly, the **LDA** instruction at the label **LOOP** (and the next **LDA** three instructions lower down) can now use the immediate addressing mode (two bytes) as opposed to the absolute addressing mode (three bytes).

The end result is that Don's self-modifying solution requires only 31 bytes, which equals the authors' best attempts above.

All credit – plus a year's free subscription to the printed edition of *EPE* – goes to Don for a very interesting solution.

CLEVER DICK!

But you could flay us with wet noodles if you think that we're going to let "Clever Dick" Don beat us (or at least match us) on his first attempt!

So let's consider what happens if we apply Don's self-modifying code concept to our last solution from Listing 3. First of all we can lose our **NEWVAL** temporary location, which saves us one byte. Next we can replace our **LDA [NEWVAL]** (absolute addressing mode) instruction with an **LDA $00** (immediate addressing mode) version, which saves us a second byte. This modified program is shown in Listing 5 (the modifications are highlighted in bold).

Listing 5

```
INPORT:   .EQU    $F010       # Constant label        =  0 bytes
OUTPORT:  .EQU    $F030       # Constant label        =  0 bytes
                              #
          .ORG    $4000       # Define start of prog  =  0 bytes
           BLDSP  $4FFF       # Load stack pointer    =  3 bytes
OLOOP:     BLDX    8          # Load index register   =  3 bytes
           LDA    [INPORT]    # Load ACC              =  3 bytes
           PUSHA              # Store ACC to stack    =  1 byte
ILOOP:     POPA               # Get ACC from stack    =  1 byte
           SHL                # Shift ACC left 1 bit  =  1 byte
           PUSHA              # Store ACC to stack    =  1 byte
NEWVAL:    LDA    $00         # Load ACC with NEWVAL  =  2 bytes
           RORC               # Rotate ACC right      =  1 bytes
           STA    [NEWVAL+1]  # Store ACC in NEWVAL   =  3 bytes
           DECX               # Decrement index reg   =  1 byte
           JNZ    [ILOOP]     # If !0 jump to ILOOP   =  3 bytes
           STA    [OUTPORT]   # Else ACC -> LEDs      =  3 bytes
           JMP    [OLOOP]     # Do it all again       =  3 bytes
                              #                         ----------
          .END                # End program     Total = 29 bytes
```

Thus, the authors' final version of this program requires only 29 bytes. "Ha! Take that Red (Don) Baron!". And of course this is absolutely the smallest solution to this problem that anyone could ever achieve in the known universe . . . unless *you* can offer a better solution . . .

A PIC device can do it in six bytes! Ed.

COMPETITION 2

When one conveys digital data from one portion of an electronic system to another or from one system to another, noise or other "glitches" may occasionally flip a bit from a 0 to a 1 or vice versa.

For example, suppose that we were to transmit a byte of information containing the value 00110111 from one computer to another, but that something occurred to flip the least-significant (LS) bit from a 1 to a 0, such that the receiving computer was presented with the value 00110110.

This could obviously cause problems, so we need some way to detect (and ideally correct) errors in our data. One of the simplest forms of error detecting codes is that of parity. For example, an extra (parity) bit can be appended to each transmitted byte of data.

The idea is that the transmitter counts all of the 1s in the original byte, and uses this number to determine the value of the ninth bit. In the case of an "Even Parity" scheme, the ninth (parity) bit would be set so as to maintain an even number of 1s. Alternatively, when using an "Odd Parity" approach, the ninth (parity) bit would be set so as to maintain an odd number of 1s. For example, consider the data bytes and their resulting parity bits shown in Table 3.

Table 3

Data bytes	Even parity	Odd parity
00000000	0	1
00000001	1	0
00110011	0	1
00110111	1	0
11111110	1	0
11111111	0	1

The transmitting unit transmits each byte along with its associated parity bit. The receiving unit generates its own parity bit for each byte and compares this to the transmitted parity bit. If the two parity bits differ, the receiver knows that an error has occurred and can respond appropriately (for example, it could request that this byte be re-transmitted).

Competition 2 is to write a program that loops around reading a value from the 8-bit switch device (connected to the input port at address $F010), generating the odd-parity bit associated with this value, and displaying this parity bit using the LS bit of the 8-bit l.e.d. display (connected to the output port at address $F030).

The judgement criteria for this competition is that the program should read the value from the switches and write the resulting parity bit to the l.e.d. display using the least number of PhizzyB clock cycles (a table of PhizzyB instructions versus clock cycles is provided in the *EPE Online Library* at **www.epemag.com**).

E-mail submissions to **editor@epemag.com**. The winner will receive a year's free subscription to the printed edition of *EPE*. The closing date is whenever we decide to "close the doors" and the decision of the judges is final!

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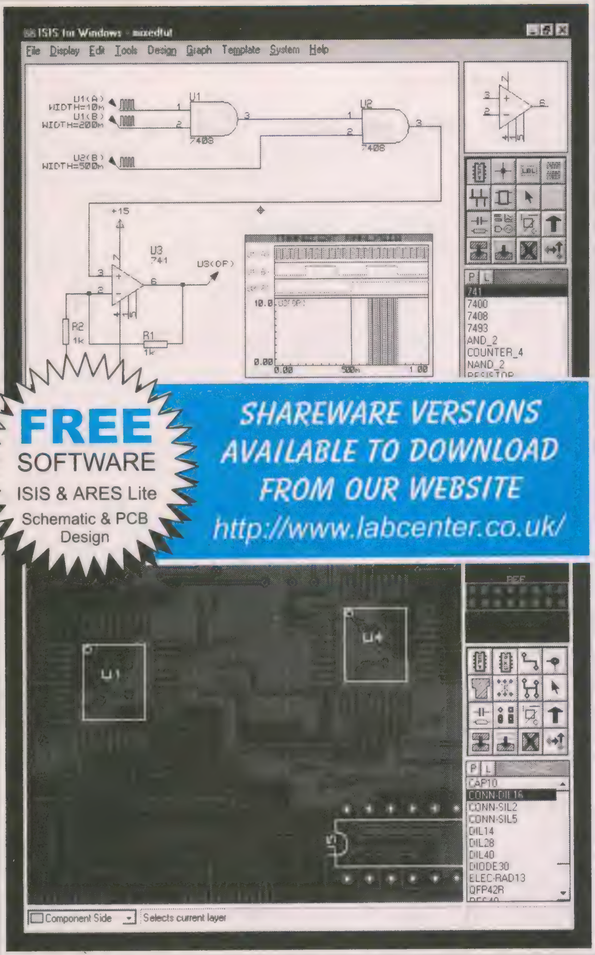

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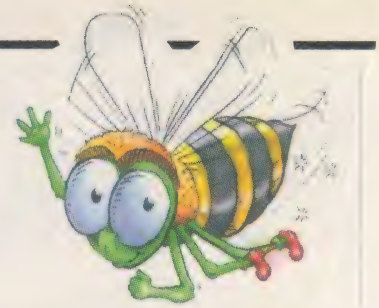


PhizzyB COMPUTERS

Construction – The PhizzyBot

Alan Winstanley

Polling and interrupts set us on course for our super wheelie – the phabulous PhizzyBot!

THIS month's practical constructional article describes the assembly and operation of a simple motorized buggy which can be guided and controlled by a suitably programmed PhizzyB. After several seconds of searching for a moniker which could be attached to Max and Alvin's latest creation, the name *PhizzyBot* was contrived, and unfortunately it appears to have stuck. So, ladies and gentlemen, start your engines, as they used to say in the golden days of grand prix motor racing.

The PhizzyBot is a two-wheel drive motor platform which can be configured to demonstrate a number of very absorbing practical assignments. In due course we will be actively investigating collision detection/obstacle avoidance as well as simple photo-sensitive applications (e.g. the PhizzyBot's inquisitive attraction to artificial light sources).

Such experiments incorporate all of the principles of computer programming which we have described in earlier parts of the PhizzyB tutorial series, as well as introducing further programming commands and techniques. Oh, and since the PhizzyBot can "feel" its way around by using a system of input detection switches, we will be able to make further use of the simple switch input devices assembled in previous months as well!

This article describes the construction of a simple motor controller which connects directly to a PhizzyB output port. A PhizzyB can then be programmed to read the state at an input port (e.g. using external microswitches that are activated in a "collision") and a control signal is then sent to the PhizzyBot motor controller board by the PhizzyB's output port.

SIMPLE AND SAFE

The PhizzyBot platform is simple and safe to construct but is remarkably effective. It consists of two d.c. gear motors which are switched by a transistor-driven relay controller. The motors are battery powered, and later on the associated PhizzyB can be powered by a 9V rechargeable battery (for example) so that a completely independent stand-alone buggy can be produced, with a PhizzyB fitted on top of the motor platform.

The PhizzyBot can then advance, reverse or rotate in either direction under the control of a PhizzyB. By incorporating other types of input circuitry, the PhizzyBot can be made to respond to other stimuli – such as a light source (i.e. an attraction to, or repulsion from – hence the possibility of a *MothBot* and *RoachBot*), or it could be made to navigate around a maze. We'll be describing more applications and ideas for the PhizzyBot in the concluding parts of this series.

In order to assemble a PhizzyBot, readers will require a hardware PhizzyB single board computer together with the full version CD-ROM of the *PhizzyB Simulator*, which runs on a Windows 95/98/NT personal computer. The PC is used to assemble the programs which are then transmitted via the PC's serial port to the PhizzyB mounted on the PhizzyBot.

The phabulous PhizzyBot!

As usual, we'll give all the necessary constructional details to enable even a novice to build the PhizzyBot with every probability that it will work first time. In order to avoid disappointment, our advice is to read through all the following details and to take your time and not to rush the construction.

PHIZZYBOT CIRCUIT

The circuit diagram for the PhizzyBot is given in Fig.1, which divides into two sections. The motor driver circuit utilises four transistor switches, TR1 to TR4, each of which controls the coil of a corresponding single-pole changeover relay (RLA to RLD respectively).

Such relays have a single contact (the "pole") which moves between two contacts labelled normally open (n.o.) and normally-closed (n.c.). Hence, when the relay coil is powered, it will connect together the pole and the *normally-open* contact. This occurs whenever the base terminal of the driver transistor is taken to +0·6V (indicating a logic "high" on its input resistor – R1 to R4 as appropriate): the transistor switches on and this completes the circuit to the relay coil.

Note that each relay coil also has a reverse-biased diode connected across its coil, in order to snub out the often substantial reverse voltage (back e.m.f.) which appears when the coil is switched off again.

MOTOR DIRECTIONS

Two small d.c. motors, M1 and M2, are used for the left and right "engines" which are controlled by the relay contacts. The circuit diagram shows the contacts in their normal (unpowered) states. *For the purposes of our articles, the descriptions of "left" and "right" are taken from a PhizzyBot driver's point of view – as if he'd been shrunk and sat on the moving PhizzyB.*

By reversing the d.c. voltage across either motor, the direction of the PhizzyBot can be controlled. Using motor M1 as an example, we see that this is switched by the relays RLA and RLB, whose contacts RLA1 and RLB1 are connected to both terminals of motor M1.

The normally-closed contacts ensure that the motor is connected to the 0V rail when neither relay is powered. This means that the motor will not operate because no voltage is present across it. Similarly, if both relays coils are switched on, then their normally open contacts will now close. Both terminals of M1 will then be connected to the PhizzyBot's +6V supply rail – which again means that the motor will not function.

However, if one of the relay contacts is "high" at +6V and the other is at 0V, then

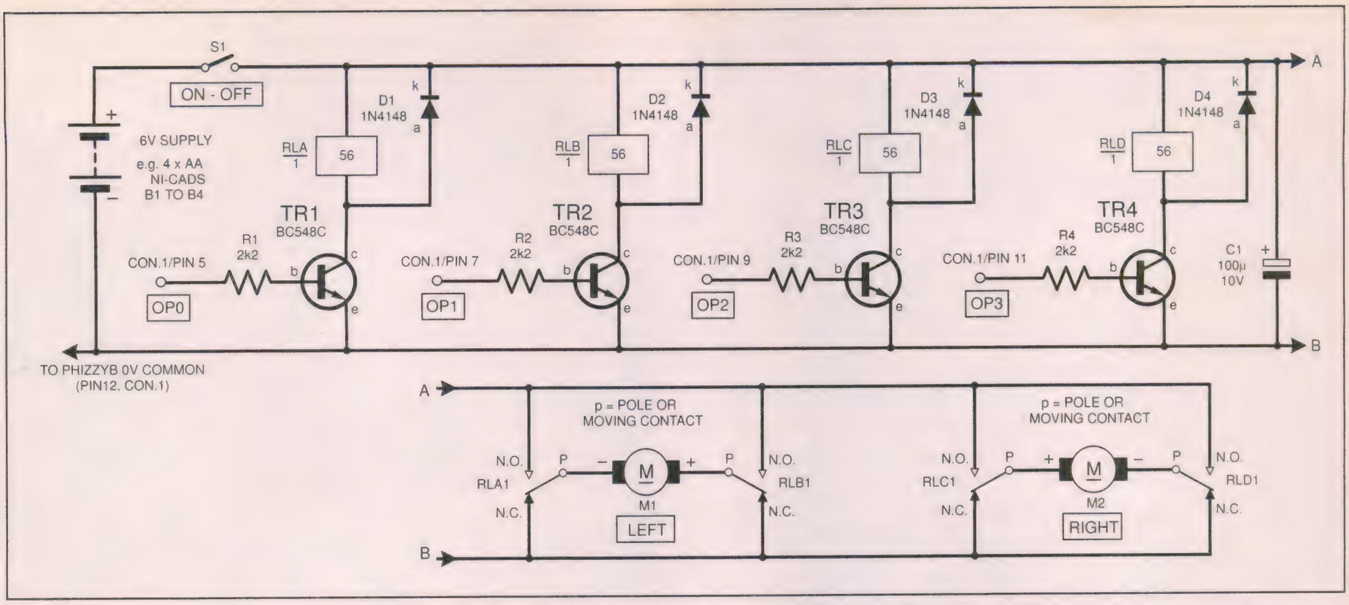


Fig.1. Complete circuit diagram for the PhizzyBot motor control interface.

the motor will be powered. If the contacts are in dissimilar states then the PhizzyBot will move, and the polarity of the applied voltage determines the direction of rotation of the motor's shaft.

It will be seen that the direction of both motors can be controlled very simply by using a 4-bit code. Each transistor's base terminal connects to the output pins OP0 to OP3 of a PhizzyB output port. By turning a transistor on or off, one terminal of the corresponding d.c. motor will be switched accordingly, and thus we can steer the PhizzyBot in the desired direction. This month's accompanying tutorial article describes how the PhizzyBot can be made to advance, reverse, steer or rotate in either direction.

The current consumption of each motor is quite substantial – approximately 500mA each as measured. Thus the PhizzyBot's motor circuit is powered by an independent 6V d.c. power supply which, on the prototype, was derived from four AA-size nickel cadmium (NiCad) cells (B1 to B4), switched by S1.

Note that the 0V rail of the motor driver circuit is also connected to the 0V bus of the PhizzyB (via pin 12 of the PhizzyB output port CON1). This is to provide a common 0V rail between the PhizzyB and the PhizzyBot. Let's now consider the assembly of the PhizzyBot.

CONSTRUCTION

The constructional method falls into three sections: the transistor driver circuit, the relay board and lastly the motorised platform which will carry the rest of the electronics, including a fully-assembled PhizzyB board! Assembly can commence with the transistor board, see Fig.2.

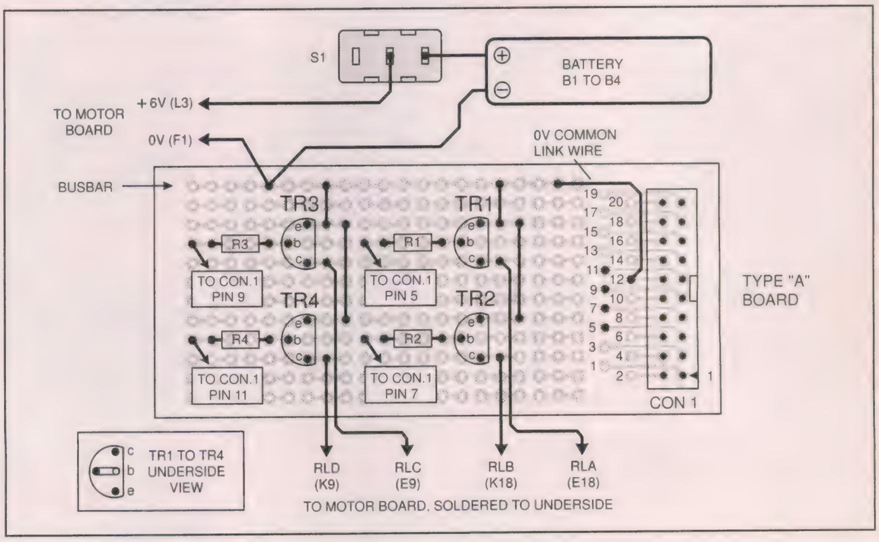


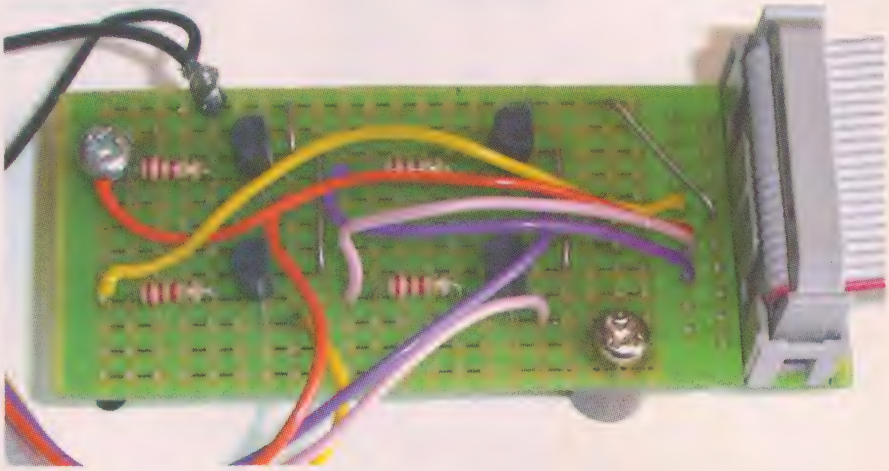
Fig.2. The transistors are mounted on their own board.

This circuit is built onto a type "A" I/O board which is cut from one quarter of a full I/O board. Drill two 3mm clearance holes for the board mounting hardware (e.g. insulated stand-offs). A good tip: use the empty board to then mark out a simple template for the drilling centres which will be needed later when the board is fitted to the platform. The circuit board stand-offs will then align perfectly!

Commence assembly by inserting the transistors which must be orientated as shown (the pinout diagram gives the base view, looking "down" the pins); being semiconductors, they might be damaged by excessive heat but, provided that the solder joints are each completed in roughly a second or so, there will not be any problem.

Continue with the resistors and tinned copper wire jumpers. A 20-way box header is used for CON1, which is orientated as shown (look for the central slot along one side, and the arrowhead for pin 1 as usual). A solitary pin header can be inserted for the connection to the 0V terminal of the battery pack B1 to B4. It will be seen that a +6V connection is not needed for this board.

At this point, four 6in (152mm) long flying leads made from general purpose hook-up wire can also be soldered, the other ends of which will eventually connect to the separate relay board. Four 2in (50cm) link wires are also needed to connect the resistors to their corresponding



Fully assembled transistor board, complete with connector.

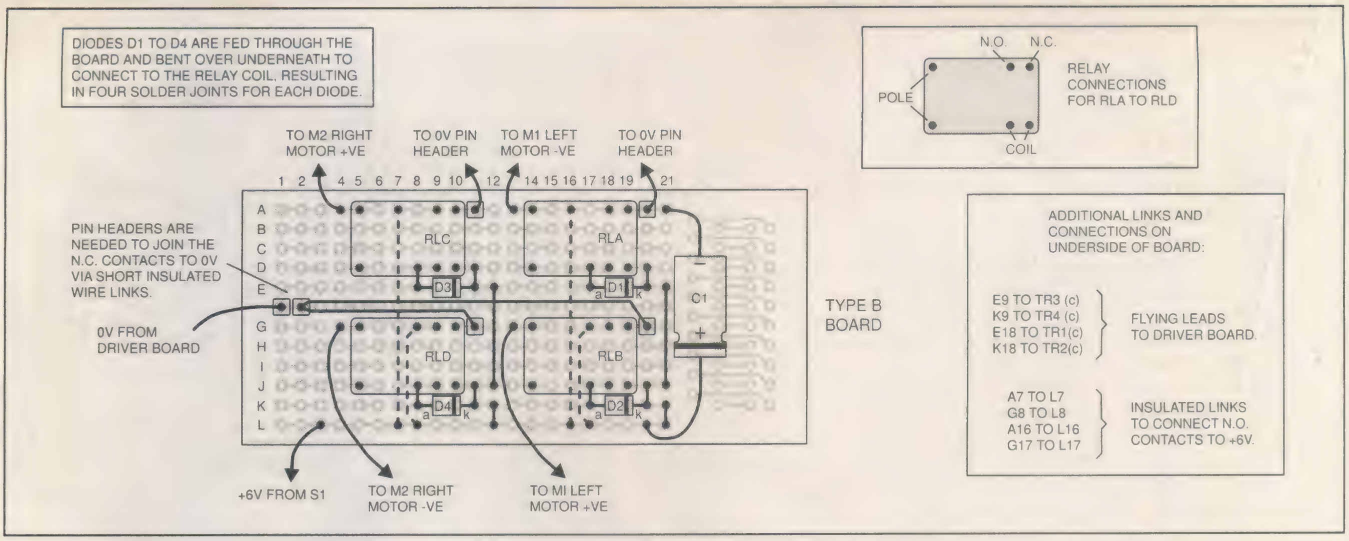
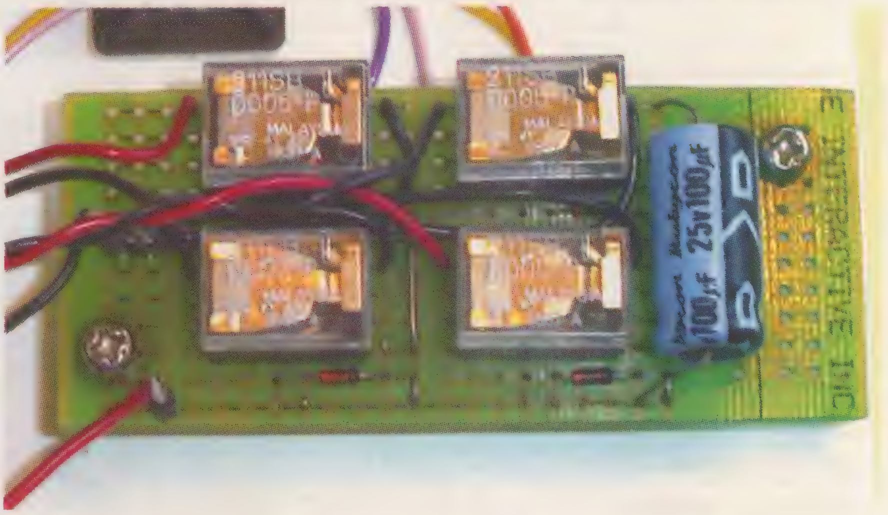

DIODES D1 TO D4 ARE FED THROUGH THE BOARD AND BENT OVER UNDERNEATH TO CONNECT TO THE RELAY COIL, RESULTING IN FOUR SOLDER JOINTS FOR EACH DIODE.
TO M2 RIGHT MOTOR +VE
TO 0V PIN HEADER
TO M1 LEFT MOTOR -VE
TO 0V PIN HEADER
1 2 4 5 6 7 8 9 10 12 14 15 16 17 18 19 21
A B C D E G H I J K L
PIN HEADERS ARE NEEDED TO JOIN THE N.C. CONTACTS TO 0V VIA SHORT INSULATED WIRE LINKS.
0V FROM DRIVER BOARD
RLC
RLA
RLD
RLB
D3
D1
D4
D2
a
k
C1
−
+
+6V FROM S1
TO M2 RIGHT MOTOR -VE
TO MI LEFT MOTOR +VE
TYPE B BOARD
N.O.
N.C.
POLE
COIL
RELAY CONNECTIONS FOR RLA TO RLD
ADDITIONAL LINKS AND CONNECTIONS ON UNDERSIDE OF BOARD:
E9 TO TR3 (c)
K9 TO TR4 (c)
E18 TO TR1(c)
K18 TO TR2(c)
FLYING LEADS TO DRIVER BOARD.
A7 TO L7
G8 TO L8
A16 TO L16
G17 TO L17
INSULATED LINKS TO CONNECT N.O. CONTACTS TO +6V.

Fig.3. The four relays are also mounted on their own board and linked to the transistor board and motors as indicated.

OP solder pads next to CON1 – **however, do not connect to the OP pins of CON1 at this stage.**

It will simplify checking and testing later on considerably if a simple colour code is adopted for all eight leads fitted (two leads of each colour). Leave the four short leads "up in the air" for now, because by connecting any of them to +6V, the associated transistor and relay can be turned on "manually" so that motors and relays can be tested.

We'll test the completed circuitry this way at the end, so put the transistor board to one side for now.



Fully assembled relay board.

RELAY STATION

The next stage is the assembly of the small relay board which was built onto a type "B" PhizzyB I/O board. Drill two 3mm clearance holes in the board for mounting, then proceed to the interwiring as shown in Fig.3. Space is a little tight but the recommended relays will all fit comfortably onto one board, so commence by soldering the four relays into place, observing their orientation (see inset diagram).

The four diodes (D1 to D4) can follow next, and **correct polarity is essential or they will be damaged when the circuit is powered. Check for a stripe which denotes the cathode terminal.** The diodes are fed through the board from above and their leads should then be cut to length and "doubled over" on the underside to connect to the relay coils. There are thus *four* solder joints per diode. Take care not to heat these semiconductor devices excessively with the soldering iron.

Insert the four tinned copper wire jumper leads from above. Four more jumper wires are suggested on the underside of the board to connect each relay's n.o. terminals to the +6V bus. Use insulated wire or PVC sleeving for these links.

The n.c. contacts have to be wired to 0V, and the prototype made use of a pair of pin headers soldered into place as shown. Four insulated wires were soldered to the n.c. solder pad for each relay, then all four wires were soldered together on the pin headers. The electrolytic capacitor C1 can be soldered on the top side and **correct polarity is very important**. A single pin header can be used for the +6V connection needed to the battery pack.

We next turn our attention to the PhizzyBot platform in order to install the two motors, after which they can be interwired to the completed relay board. We will then be ready to test the motor driver circuitry, and at the same time the connections to OP0-OP3 will be finalised to ensure that both PhizzyBot motors respond correctly to some simple control commands (see "Final testing" later).

PHIZZYBOT CHASSIS

The PhizzyBot chassis was constructed from 1/16in (1·6mm) Plasticard which is available from model shops. It is somewhat flexible but this is not a problem because the PhizzyB circuit board will add rigidity. It is considered feasible that thin gauge aluminium sheet could perhaps be used as a stronger alternative, but the plasticard was cheap and lightweight and was very easy to work with and forms a good basis for prototyping.

Approximate dimensions of the prototype are shown in Fig.4. The underside view of the platform is shown (so that it is clear which motor is "left" and "right"). An area approximately 5in × 1in (127mm × 25mm) protrudes from the front to allow leading-edge sensors to be fitted later, e.g. for use as a white line follower. Dimensions are not too critical.

Since the top of the PhizzyBot platform carries a hardware PhizzyB single board computer, the underside of the platform is used to mount the two motors, the battery

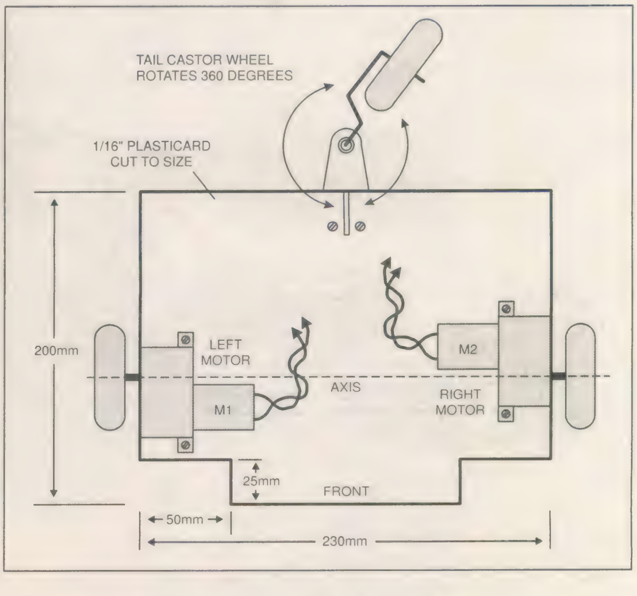
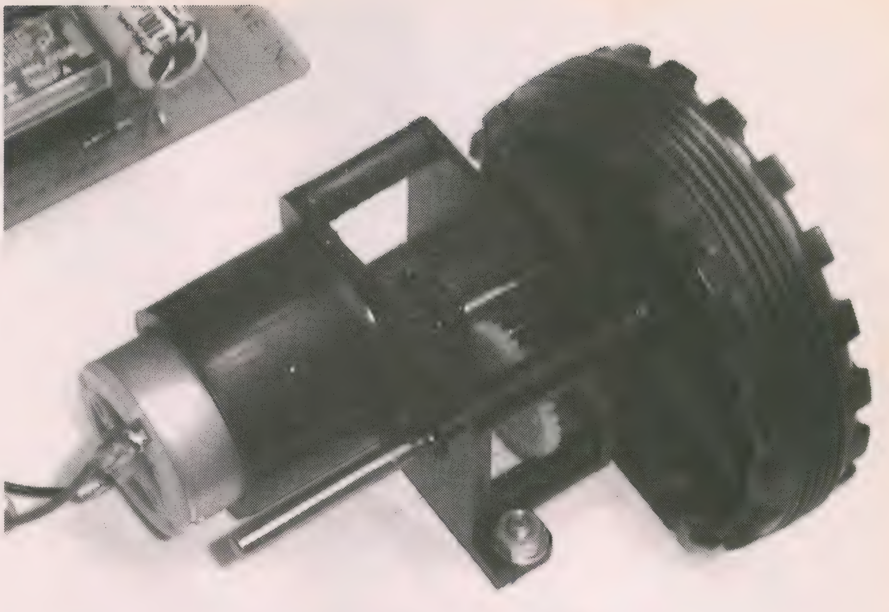

TAIL CASTOR WHEEL ROTATES 360 DEGREES
1/16" PLASTICARD CUT TO SIZE
200mm
LEFT MOTOR
M1
M2
AXIS
RIGHT MOTOR
25mm
FRONT
50mm
230mm

Fig.4. Dimensions of the PhizzyBot platform.



Close-up detail of a motor and its wheel.

pack and the transistor and relay boards. A short ribbon cable will then interconnect the transistor board and the PhizzyB – see photos.

Recommended gear motors are stated in the components list, but alternative types could be utilised. The suggested ones are multi-ratio 1·5V to 4·5V d.c. motors with self-assembly gears.

They should be assembled as per the instructions included, selecting an initial speed of 74 r.p.m. at 4·5V supply. Therefore, four black gears are used, and three or four spacer washers (supplied) are used to take up the remaining free space on the drive axle. The gearmotors are bolted into position – *remembering that the two axles must align along a common axis,* see Fig.4. Astute readers will soon realise that if the PhizzyBot is to move forward, the two motors must therefore rotate in opposite directions – but let's worry about that later!

Unfortunately, during assembly the author found it impossible to close the plastic gearboxes together fully because the length of the two internal shafts prevented everything seating reliably. Some care was needed not to force everything together or the plastic gearbox housing could be easily damaged.

In the end, a solution was achieved by carefully grinding a fraction of a millimetre from the two shorter shafts using a Dremel sanding disk. This completely cured the problem and allowed the gear housings to be snapped together successfully. Readers will soon be able to determine if similar remedial action is needed.

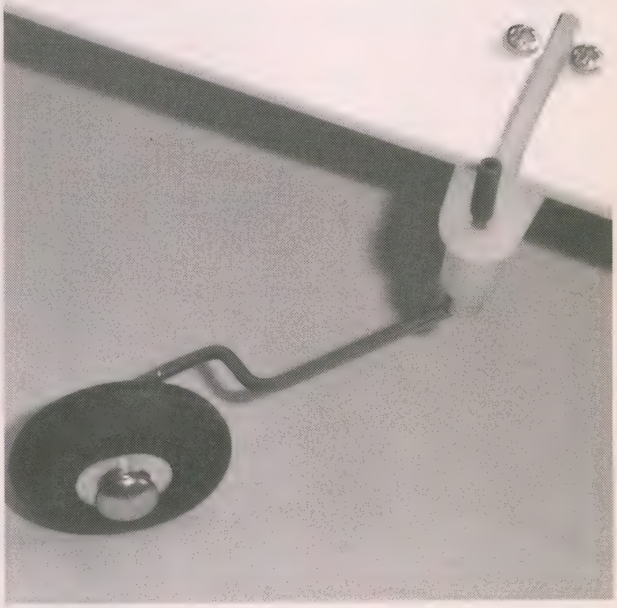
Several drops of light oil are essential on the gears. (Apart from that, your PhizzyBot does not need a 12,000 mile service interval!)

PHIZZYBOT IS WHEELY COOL!

The gearmotors are surprisingly powerful and propel the complete PhizzyBot with ease but the efficiency of the completed PhizzyBot depends entirely on the type of wheels used. After some interesting trials the author eventually settled for 56mm diameter push-on rubber tyres which are very "grippy" and easily transport the PhizzyB along any carpeted or smooth surface.

The tyres must be of sufficient diameter to enable the motors and circuit boards to clear the ground. Only cut the motor drive shafts to length when suitable tyres have been tested, and the recommended tyres simply push on with a tight fit and are perfect for the job. Each completed gearmotor can be tested using a d.c. battery up to 4·5V or so.

The rear wheel is just a stabilising "jockey" wheel, and a model aircraft freewheel with rubber tyre. This can be fitted centrally along the rear edge. Happily, this performs perfectly in that when the PhizzyBot reverses, the wheel swings round underneath the platform to become the "leading" wheel. It swings back out and trails the platform when the PhizzyBot moves forward again.

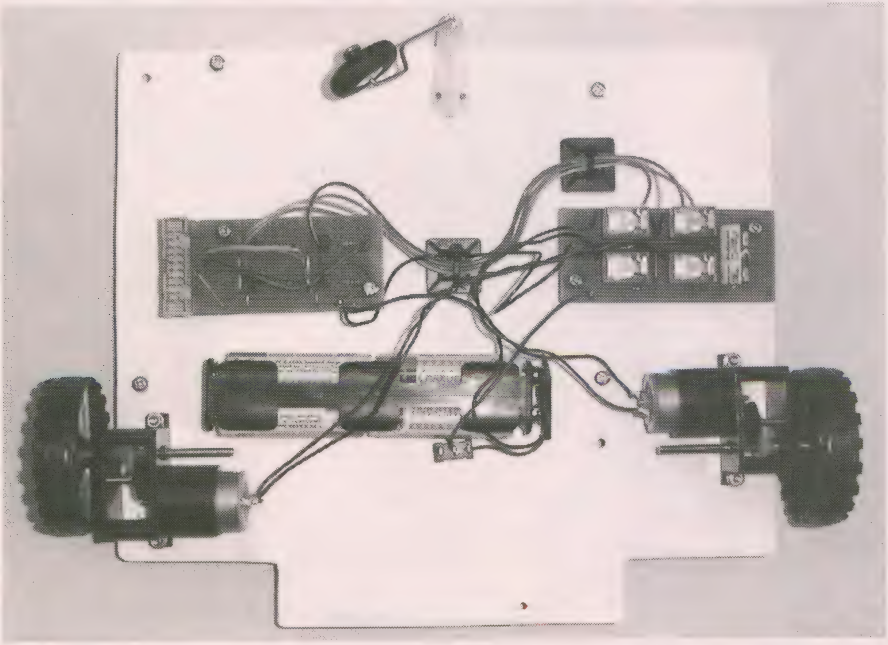


The "jockey" wheel mounted in position.

Simply cut a slot in the chassis and screw the mounting bracket into place, then bend the wheel's wire arm to ensure that the PhizzyBot is roughly level. A short piece of PVC sleeving can be fitted tightly over the wire end to prevent the arm falling through. All of the parts fitted to the underside should then be clear of the ground.

Continue construction by completing the interwiring between the relay and transistor board, plus the two motors themselves. Keep the motor wires as short as possible, and they can be soldered directly to the relay board. The motors should have a polarity marking and there will probably be a "+" sign moulded next to that terminal.

In order to allow for the fact that one motor must rotate in the opposite direction to the other for them to both transport the PhizzyBot in the same direction, note the polarity markings of the motor interwiring as shown in Fig.3. A simple test (see later) will soon confirm that the set-up is correct.



The underside view of the motor platform showing the complete PhizzyBot hardware in position.

At this stage, do not solder those four short wires OP0-OP3 on the transistor board to CON1 just yet, but you can hook over the long flying leads to the relay board. Nylon tie wraps and stick-on bases are useful for tidying up the wiring, or dabs of hot-melt glue can be used to tack down the wiring.

You can now plan for fitting the transistor and relay boards underneath the platform. The author recommends using M3 (3mm thread) standoffs, 10mm high. Some care is needed when positioning the circuit boards (see photos). *The main consideration is that CON1 on the transistor board must align approximately with the output port $F032 on the PhizzyB above it.* A short 20-way IDC ribbon cable then connects the two neatly.

It will then be seen that there is sufficient clearance underneath the platform to accommodate CON1 and the ribbon cable plug, but do not fit the ribbon cable at this stage until final testing is complete.

The PhizzyB can then be carefully fitted on the top, using M3 standoffs once again. The motor driver boards can be screwed into place when all soldering is completed. Henceforth, you will find it easier if you use, for example, an upturned bowl or pot to rest the upturned PhizzyBot during assembly (take care to avoid damaging the PhizzyB's back-up battery when the unit is turned upside down).

Turning our attention to the power source needed for the completed PhizzyBot, at a later stage it will be feasible to power a PhizzyB from an on-board 9V battery. This will allow the PhizzyBot to operate as a completely independent stand-alone buggy.

The author used an ordinary 9V Ni-Cad battery for testing: a simple power lead was made from a battery snap-on clip and a d.c. power plug, which enabled a 9V rechargeable battery to plug directly into the PhizzyB board in lieu of an external power supply. For now you should use the external mains adaptor as usual, with the PhizzyB raised up on the bench so that it freewheels.

As previously noted, the author used a set of four "AA" Ni-Cad cells to power the motor circuit. Expect 30 to 40 minutes before recharging is necessary. A low-profile battery holder was stuck down under the platform using double-sided sticky pads. A single toggle switch was used for S1, fitted onto the platform centrally.

FINAL TESTING

The final aspect is to test the transistor and relay board, in order to ensure that the motors operate in accordance with the following truth table:

LEFT			RIGHT		
OP1	**OP0**		**OP3**	**OP2**	
0	0	–	0	0	–
0	1	Reverse	0	1	Reverse
1	0	Forward	1	0	Forward
1	1	–	1	1	–

A "1" in the table indicates a logic high, which means that when a particular OP line is high, the corresponding relay will switch on and the relevant motor will operate. By applying a little reverse engineering, we can make life easy for ourselves and force the PhizzyBot to behave as required simply by testing the four inputs OP0-OP3 on the constructed platform, see what happens and then solder the four OP flying leads to the appropriate connections at CON1.

COMPONENTS

See SHOP TALK page

Resistors

R1 to R4	2k2 (4 off)
All 1/4W 5% carbon film	

Capacitor

C1	100µ axial elect. 16V

Semiconductors

TR1 to TR4	BC548C or any general purpose *npn* transistor (4 off)
D1 to D4	1N4148 signal diode (4 off)

Miscellaneous

S1	s.p.s.t. miniature toggle switch
B1 to B4	"AA" Ni-Cad cells (4 off)
RLA to RLD	s.p.c.o. min. relay, 5V 56Ω 1A, p.c.b. mounting, Fujitsu FBR211 series (4 off)
M1, M2	1·5V to 4·5V d.c. gearmotor (Como 430G) (2 off)
CON1	20-way IDC box header

PhizzyB I/O board, "A" type and "B" type (1 each); 56mm × 16mm solid rubber wheels (2 off); model aircraft tailwheel; Plasticard, 9in × 8in × 1/16in (228mm × 203mm x 1.6mm) gauge or to suit (see text); low profile 4 × AA battery holder; battery snap connector; M3 × 10mm mounting pillars (8 off); connecting wire; solder, etc.

The 20-way IDC lead and interrupt board required for this part have been constructed previously. (Fluffy dice and go-faster stripes are optional!)

Approx. Cost Guidance Only £29 *excluding batteries*

Do this as follows: raise the PhizzyBot off the bench. Ensure CON1 is disconnected from the PhizzyB, then snap on the battery pack and switch on the +6V supply to the driver boards. None of the motors should turn, and none of the relays should be heard to click. Temporarily hook the flying leads from the four resistors R1 to R4 in turn to +6V (this equals a logic 1). This should switch on the associated relay and the corresponding motor should then operate.

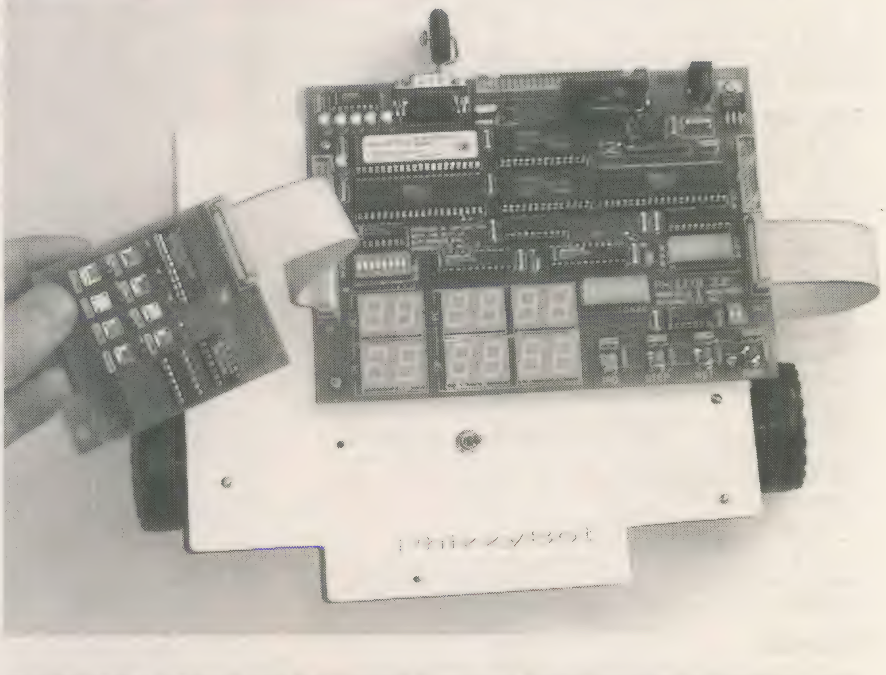
Try all four leads and see what happens. Prove that each relay powers up, and check that both motors operate in both directions properly. It can require some mental gymnastics to work out what is left, right, forwards and backwards! Remember that we take the PhizzyBot "driver's eye" view in this respect.

From the simple tests you can confirm which OP signal wire performs which function. If all is well and you have followed the diagrams then you will be able to prove the truth table given above, so go ahead and complete the interwiring to CON1 on the transistor board, guided by Fig.2 which gives the wiring details. All that remains is to fit the boards to their mounting pillars and tidy up the interwiring, then your PhizzyBot is ready for action!

DRIVING TEST

We are pretty sure you can't wait to road test your PhizzyBot, so here is a simple test routine which will confirm for sure that your PhizzyBot is behaving itself. Hook up the motor driver board to output port $F032 using a ribbon cable, and use the 8-bit interrupt switch device constructed in Part 4, connected to the $F012 input port with a second ribbon cable. Enter and save the routine in Listing 1 as **motortest.asm** then download it to your PhizzyB mounted atop the PhizzyBot platform. This is based on the original interrupt program from Part 4. If you then click and release:

Switch S0 – motor 1 (left) backwards
Switch S1 – motor 1 forwards
Switch S2 – motor 2 (right) backwards
Switch S3 – motor 2 forwards


The PhizzyBot platform with the PhizzyB computer board mounted in position, plus the temporary connection of the switched control board.

Listing 1

```
                .ORG     $4000
                BLDSP    $4FFF
                BLDIV    IRRUPT
                SETIM
                LDA      $00
                STA      [$F032]
LOOP:           JMP      [LOOP]
IRRUPT:         LDA      [$F012]
                XOR      $FF
                STA      [$F032]
                RTI
                .END
#This is the end of the file
```

Clicking switches S4 to S7 (see Fig.4 of last month's constructional article) will stop both motors. Thus the PhizzyBot can be made to zig-zag around the floor! Further tests can be made using a full 10 feet (3 metres) length (no less!) of ribbon cable on the interrupt latch board and happily the prototype should respond to every command, trundling around the floor and sounding like a food blender on steroids.

A variation of the above routine is used in the main tutorial article, in which Max and Alvin describe how to program some fundamental control commands for the PhizzyBot. You will probably find it best simply to raise the motor platform off the bench top for the purposes of this month's tutorial, and it will be adequate, therefore, to use the mains adaptor for the PhizzyB's power source at this time.

HELP IS AT HAND

If you have any problems related to the constructional aspects of the series, you can contact the author by E-mail at **alan@epemag.demon.co.uk** or by writing to the Editorial address. Don't forget that Max and Alvin love to hear from you too, by E-mail to **max@maxmon.com.**

And if you're new to the PhizzyB (where have you been that you missed parts 1 to 4? – if you are an ETI reader we extend a very warm welcome to you!) we can supply back issues of the previous parts – see this month's Back Issues page).

NEXT MONTH

Next month, we'll be adding sensory switches to the PhizzyBot and will introduce more computer programming techniques, using the principles of collision detection as a further example of the PhizzyB's versatility as a computer teaching aid and control system.

PhizzyB "LITE"

Undoubtedly some of you reading about our phabulous PhizzyBot will be longing to build it but have not built the PhizzyB itself – well, you don't have to build the whole shebang in order to run our wheely, you can omit a number of PhizzyB parts. Here's a list of what you can omit (you can always add them at a later date if you wish)

* IC5 (32K RAM) and its d.i.l. socket
* IC7 (memory battery back-up controller
* IC10 and IC102 (two display drivers) and their d.i.l. sockets
* BAR101 (status register 10-bit l.e.d. bargraph)
* DUAL1 to DUAL6 (7-segment displays)
* CON1 (50-way boxed header connector)

In this case we believe that a PhizzyB "Lite" would cost not much more than half that of a fully-populated PhizzyB.

Please refer to the full components list on page 812, November 1998 issue for more details.

SHOP TALK

with David Barrington

Smoke Absorber

Extracting a source for the components for the *Smoke Absorber* project should not prove too difficult. The main problems could be the infra-red detector, low voltage fan, filter and finger guard.

Regarding the surface mount devices (SMDs), these are now widely stocked by advertisers but you will probably have to buy in minimum quantities. You could try ***Electromail*** (☎ ***01536 204555***) or **Maplin** (limited range).

The PIS201S passive infra-red detector, with an internal f.e.t. amp, was purchased from a Maplin store, code AJ77J. The 12V brushless d.c. fan also came from them (code YZ38R, 60mm version), together with the charcoal filled filter pad (code BN91Y) and the 60mm square finger guard (code JU23A; two required). The filter pad will cost around £10 and comes in a much larger size than needed and will have to be cut to size.

The Sentinel galvanised wire mesh should be stocked by garden centres. Once gain, like the filter pads, it will be necessary to purchase a piece larger than required and cut it down to size.

The plastic project box came from Maplin, code LF01B, and the surface mount ZVN2106G MOSFET from Electromail, code 274-992. The small surface mount printed circuit board is available from the *EPE/ETI PCB Service*, code 223 (see page 220).

Finally, those readers having access to the Internet and wishing to know more about surface mount may like to "visit" the author, Bill Mooney, on the web at: ***www.billssmd.mcmail.com***.

Time and Date Generator

A few points need to be raised regarding components for the *Time and Date Generator* project. The only listing we have spotted for the EL4581 video sync separator i.c. has been **Maplin**, code AJ62S. The rest of the ``semiconductor'' devices should be generally available.

The PIC16C84-10/P should be the 10 meg version. If you do not wish to program your own PIC chip, a ready-programmed PIC16C84-10 microcontroller is available from **Magenta Electronics** (☎ ***01283 565435*** or ***http://www.magenta2000.co.uk***) for the inclusive price of £5.90 each. Overseas readers add £1 for postage.

If you do intend to do your own programming, the software listing is available from the Editorial Offices on a 3·5in. PC-compatible disk, see *EPE/ETI PCB Service* page 220. There is a nominal admin charge of £2.75 each (UK), the actual software is *Free*. For overseas readers the charge is £3.35 surface mail and £4.35 airmail. If you are an Internet user, it can be downloaded *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/timedate**.

You can replace the 2-way jumper links with straightforward bare wire links. If you wish to use the "bridging" jumpers, these can be ordered from Maplin, codes UL70M (pin jumpers) and JW59P (pin strip). The interlocking 2-way 5mm, p.c.b. mounting, right-angle terminal block should be widely available. The printed circuit board is available from the *EPE/ETI PCB Service*, code 221.

PhizzyBot

Casting a quizzical eye over the parts needed to produce *PhizzyBot*, our motorised buggy, some of the major items appear, at first sight, as though they could give some readers headaches locating a supplier. The relay and motors are likely to be the main culprits.

The low voltage, 1·5V to 4·5V d.c., Como 430G gearmotor is currently being advertised by **Magenta Electronics** (☎ ***01283 565435*** or ***http://www.magenta2000.co.uk)*** and is listed as MGS (small); there is a postal charge. Model shops may stock similar types.

Turning to the relay. This is from the Fujitsu FBR211 series and is currently held by **Farnell** (☎ ***0113 263 6311*** or ***http://www.farnell.com***), code 103-063.

If you cannot find suitable solid model rubber wheels or an aircraft tailwheel at your local model craftshop, we have found that **Maplin** (***http://www.maplin.co.uk***) can supply them. When ordering quote code WC94C (4 pack) for the wheels and code LJ61R for the tailwheel assembly.

You will also need the 4-section PhizzyB I/O printed circuit board. This is obtainable from the *EPE/ETI PCB Service*, code 216.

Auto Cupboard Light

If you are unable to find a suitable cord-operated type cupboard lamp for the *Auto Cupboard Light* at your local electrical store, then we suggest you use the one listed by **Maplin**, code KR34M.

The choice of miniature 6V d.c. relay for this project is important, as apart from it being physically identical, if it is to fit on the small printed circuit board, it must also have contacts rated at 2A minimum to handle any switch-on current surge. The one in the model also came from the above mentioned source, code FM91Y.

The author calls-up a mercury filled tilt switch from Maplin, code FE11M. However, due to the highly toxic nature of mercury, we would suggest readers go for the *non-mercury* version, code DP50E. Both types are obtainable from Maplin.

A deep-seated lid section is required for the circuit board control case and the recommended one used in the model is the ABS plastic BM12 type listed by the above, code CC82D. No doubt some of our excellent components advertisers will be able to come up with something similar. The printed circuit board is available from the *EPE/ETI PCB Service*, code 222 (see page 220).

Wireless Monitoring System–2

Having investigated any possible buying bugs for the *Wireless Monitoring System* in last month's *Shoptalk*, we only have some good news to pass on this month. The f.m. versions of the transmitter and receiver modules are also stocked by the companies mentioned last month.

We understand that **Radio-Tech** (☎ ***01992 576107*** or ***htpp://www.radio-tech.co.uk)*** are presently running a special offer on Radiometrix modules. They are offering a free *additional* transmitter module with every order placed for a *pair* of f.m. modules. We suggest you contact them to see if it applies to this month's f.m. adaptor circuits, quote reference EPE-RM1.

Those readers unable to program their own PICs can purchase ready-programmed PIC16C71s for the Transmitter and Receiver from **Magenta Electronics** (☎ ***01283 565435*** or ***http://www.magenta2000.co.uk***) for the inclusive price of £5.90 **each** (overseas add £1 for p&p). There are two versions of the Transmitter software: one for the Tilt sensor, and one for the Temperature sensor. Please indicate version(s) required.

The f.m. adaptor p.c.b.s come with the main a.m. printed circuit boards. See the *EPE/ETI PCB Service* page 220 for prices.

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing it!

MOST panel mounting components are very easy to fix in position, and in the majority of cases a single fixing hole of modest diameter is all that is required. Inevitably there are a few components that are more difficult, and this is usually due to their large size and the large mounting holes that they consequently require.

In this month's article we will consider some of the numerous ways of dealing with large panel cutouts. There is a wide range of tools available for carving large pieces out of metal and plastic panels, but provided you are in no great hurry, some simple and inexpensive tools will suffice.

Moving coil panel meters remain quite popular for use in home constructor projects, and they are a good example of a component that has unusual mounting requirements. The standard mounting arrangement for a normal moving coil panel meter having a front plate of about 60mm by 45mm is shown in Fig. 1.

The four small mounting holes are for the threaded rods built into the meter itself. The meter should be supplied with matching washers and fixing nuts. There is no difficulty in marking the positions of these as they are simply at the corners of a square having 32mm sides.

Getting the Needle

The large (38mm dia.) cutout accommodates the body of the meter, and its centre is at the middle of the square. This cutout has to be made quite accurately, since the meter will not fit if it is fractionally undersize, and it will tend to engulf the four smaller holes if it is made slightly too large.

There is an obvious problem in making a hole of this size, which is larger than normal methods of drilling can accommodate. The cheap way of attacking any large cutout, whether regular or irregular in shape, is to use a miniature round file. For obvious reasons, these are also known as "needle" files.

One or two of these files or even a complete set of assorted shapes and sizes is something that you should buy sooner rather than later. While files do not represent a quick way of making large cut-outs, they do at least provide you with a means of making virtually any required hole no matter how large or irregular in shape.

The best needle files for making cutouts are "Abrafiles". These can sometimes be a bit difficult to track down, but they will probably be available from at least one of your local DIY superstores.

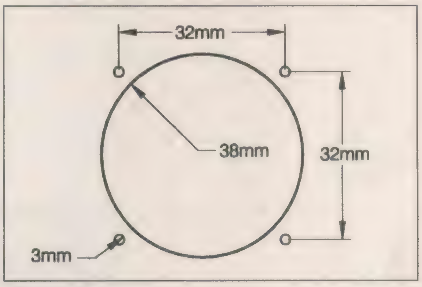


Fig.1. Mounting holes for a panel meter look easy enough, but a 38mm dia. hole can be awkward to produce.

Their main claim to fame is (literally) their flexibility, and these files can be bent to reach inaccessible places. This ability is probably of no great importance in the current context, and the bigger asset is their coarseness, which enables them to cut relatively quickly. You can obtain an Abrafile that fits into a special frame that looks rather like a coping saw.

Cutting quickly and accurately with one of these is very easy, and the ability of the blade to cut in any direction makes life much easier than using a fretsaw or coping saw. On the other hand, the frame prevents the tool from making holes towards the middle of large panels, whereas simple needle files can make cuts just about anywhere in any panel.

Don't Fret

If you have a fretsaw or a coping saw it is worth giving it a try when making large cutouts. There are blades specifically for cutting metal and plastic, but virtually any coping/fretsaw blade seems to cope with aluminium and plastic panels quite well.

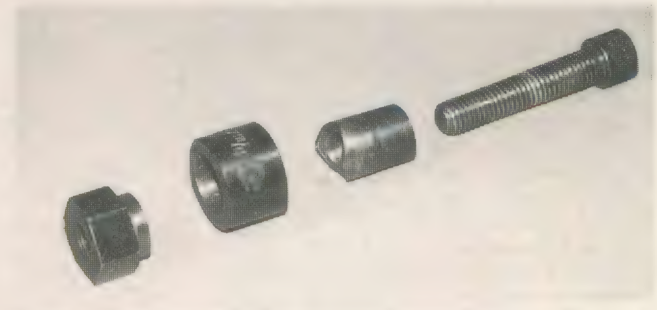
With any of these filing and sawing methods it is necessary to drill a hole of about three millimetres in diameter first, and then work outwards from this starting point.

Patience is important with any creative hobby, but is especially important when cutting anything. Go at things like the proverbial "bull in the china shop" and you will at best make a mess of the job, and at worst you will injure yourself.

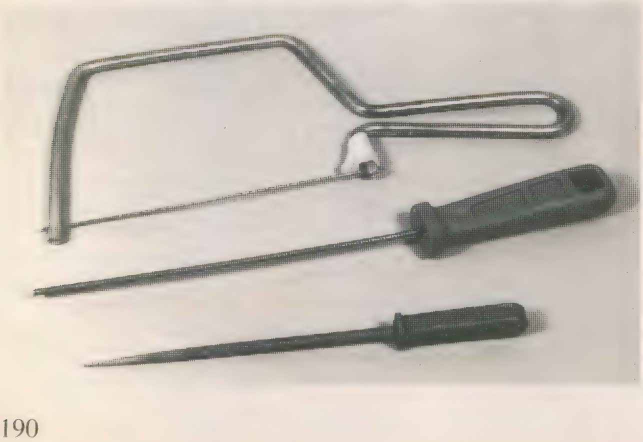
Even if you are very skilful at using saws and files, it is still advisable to cut just inside the line marking the required cutout. A file can then be used to carefully enlarge the cutout to precisely the required size and shape. Provided suitable time and care is taken over the exercise, even those who are "practically-challenged" should find that this method enables them to produce some quite neat and accurate results.

The importance of good accuracy is something that varies from job to job. In the case of something like a panel meter there should be no major problem provided the main mounting hole is not made so large that it does not leave anywhere for the four smaller ones. If necessary, the meter will cover a multitude of sins when it is fixed in place.

With some components, such as push-fit rocker switches, there is practically no margin for error. Make the cutout fractionally too small and the switch will not snap into place. Make the hole slightly too large and the switch will be a very obvious loose fit, and may refuse to stay in position. With any push-fit components it is a good idea to make the mounting hole slightly too small initially, and to then gradually enlarge



The four main parts of a chassis punch (above). The cutting blade (second right) is forced through the panel and into the die (second left). This produces very neat and accurate results.



(Left) The frame version of the Abrafile (top) and the standard version (middle) provide an inexpensive means of handling practically any cutout. The miniature round file (bottom) is equally versatile, but can be quite slow.

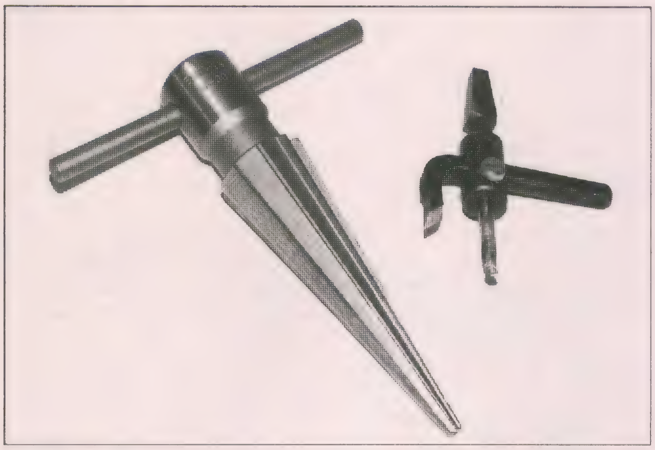
it until the component fits into place properly.

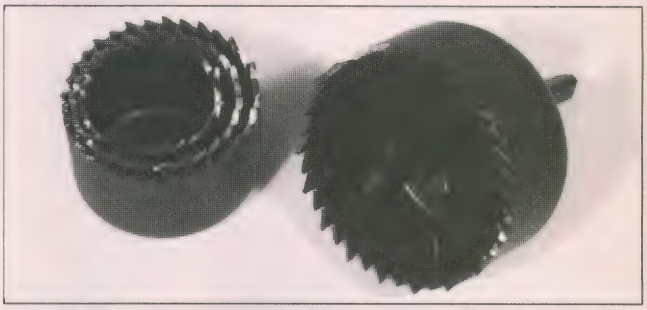
Ring Around

When using needle files that have fine blades it can take a very long time to make large cutouts. There is a simple but effective way of speeding things up, and this is to drill a ring of 3mm to 3·5mm diameter holes just inside the perimeter of the required cutout.

The holes should be about 4mm or 5mm apart so that there is a small gap between them, but the gap should be kept quite small. The needle file is then used to join up the holes and complete the cutout.

Most of the material is removed by the drilling, which does not take long despite the large number of holes involved. This leaves relatively little to do with the needle file and greatly speeds things up. The resultant cutout will probably have some rough edges, but it will not take long to file it out to a hole of the correct size having a neat finish.





(Above) Hole-saws produce neat results and are quite fast. They work best in a power drill set to a slow speed. (Left) A reamer can turn a small hole into a larger one, up to about 30mm. The tank cutter (right) can handle holes having diameters from around 25mm to 120mm.

Quick Cuts

Where a large round mounting hole is required, such as for a panel meter or a loudspeaker, there are quick ways of making the hole. A chassis punch is a tool that makes the "cleanest" holes, and it is also very quick. It consists of four main pieces, see photograph.

A small guide hole is drilled in the panel, and a bolt with the circular cutting blade attached is fitted into this. A nut and a short metal tube are then fitted onto the bolt on the other side of the panel. The bolt is tightened with the aid of an Allen key, forcing the cutting blade through the panel and into the tube. In doing so it punches a round hole in the panel.

In fact there are chassis punches that produce rectangular holes, including some that are designed to produce accurate holes for push-fit switches. Unfortunately, the relatively high cost of chassis punches makes them impractical for one-off or very occasional use, and you will probably only use the round variety.

In The Hole

A chassis punch is fine for holes of up to about 30mm in diameter, but larger sizes are difficult to obtain and it can be difficult to use them with anything more than thin aluminium panels. For larger holes a "hole-saw" is a better option.

This is basically just a saw blade in the form of a ring, plus a mandrel that enables it to be mounted in a hand drill or power drill. The mandrel includes a drill bit that produces a guide hole of a few millimetres in diameter. The blade then comes into action and produces the main hole.

The blades are quite thick, which means that quite a lot of material is removed when cutting the hole. However, with a power drill on a slow setting it does not take long to produce holes having diameters of around 30mm to 60mm. Provided the saw is not seriously worn, the holes should be quite "clean" and neat.

There is an obvious limitation with hole-saws and chassis punches in that each one can only produce one size of hole. Buying several tools of either type individually can be quite expensive, and it is worth considering one of the sets of popular sizes that are available. Although the tools in these sets are not usually of the highest quality, they seem to be adequate for dealing with the aluminium and plastic panels encountered in project construction.

Unless you have proper workshop facilities and high quality tools it is advisable not to try making large cutouts in steel panels. Tools that cut through softer materials with no difficulty will usually need a lot of lubrication in order to cut through steel, and may break under the strain.

There is an inexpensive alternative to chassis punches and hole-saws in the form of hole cutters, or "tank" cutters, as they are also known. Tools of this type are available from most DIY superstores.

A hole cutter is a bit like a hole-saw, but with only one tooth on the end of an adjustable arm. By adjusting the effective length of the arm it is possible to produce holes from typically about 25mm up to around 120mm in diameter.

These tools are very quick and effective, but a few points need to be borne in mind when using them. First and foremost, they are *only* intended for use in a *hand brace*, and should *not* be used in power drills. They are designed to operate at very low speeds, and do not even work properly using most hand drills.

They are just about usable with a heavy-duty hand drill set to its slower speed, but only when used to make holes of up to about 40mm in diameter. A brace gives the best results and enables large holes to be handled with ease.

A hole cutter is surprisingly fast even when cutting very large holes, but it does not produce neat results. A substantial amount of filing is usually required in order to "clean" the hole, and the hole therefore tends to grow. Consequently, it is necessary to cut a hole one or two millimetres smaller than the required size to allow for this "inflation".

Cheating

Where possible, you may prefer to avoid large cutouts. In most cases this is not possible, but with miniature loudspeakers there is an alternative to the "text book" approach.

Normally the panel is drilled with a hole that is slightly smaller than the overall diameter of the loudspeaker, and some speaker cloth or fret is then glued in place behind the cutout. It is very unusual for miniature loudspeakers to have any provision for screw mounting, and they invariably have to be glued in place on the speaker material.

Any good quality general-purpose adhesive should do this well enough, but glue-guns are now remarkably cheap and offer the quickest means of handling jobs of this type. Avoid smearing adhesive onto the diaphragm of a speaker as this could seriously impair its performance.

The alternative to the conventional approach is to drill a matrix of small holes in the panel to form a simple speaker grille. The loudspeaker is then glued in place onto the panel, behind the matrix of holes.

Making a neat job of this is trickier than you might think, and it is a job that needs to be given due care and attention. It is best to drill small guide holes first and then enlarge these to the required size. An advantage of this approach is that it should leave the panel quite stiff and strong.

Making large cutouts in small panels can cause serious weaknesses and is best avoided.

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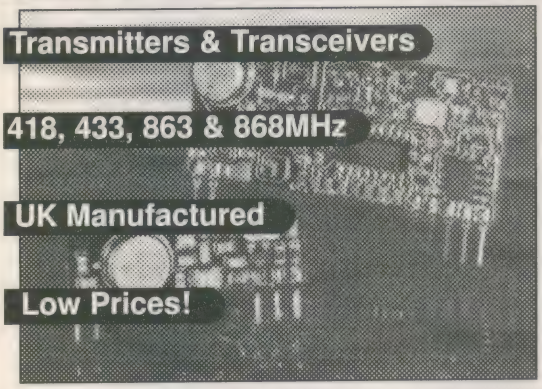

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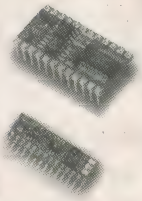

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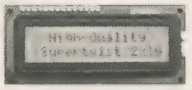

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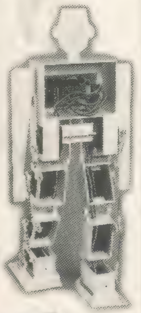

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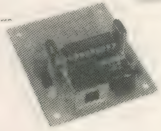

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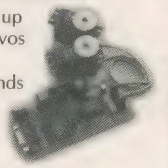

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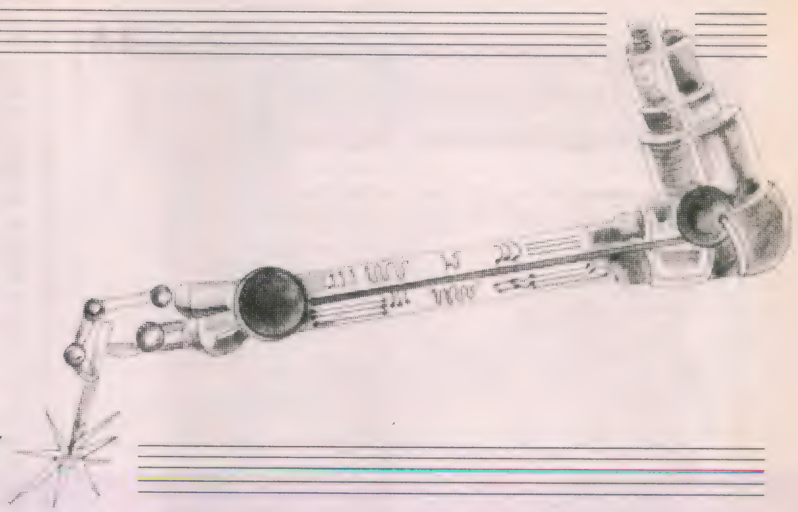


ALAN WINSTANLEY

This month's roundup of readers' queries and comments follows up with more information on electret microphones, a quick capacitor check with ohmmeters and some pointers for using variable regulators.

THE QUESTION of using variable voltage regulators to produce simple power supplies crops up from time to time. Here's a query from ***G. A. Wilsher*** of Teddington, Middlesex.

Regulators sum it up

I have been waiting patiently for a ''decent'' Bench Power Supply unit to appear when I came across the variable regulator LM338 which will produce an output from 1·2V to 32V at 5A, and this would give me exactly what I'm looking for. Although I could manage such a design on stripboard I would appreciate some guidance.

I happen to have a transformer with bridge rectifiers and smoothing capacitors which produces 50V d.c. The LM338 specification states that the difference between input and output voltages should not exceed 35V. What are the implications of this? Second, I can see that two resistors are required to set the voltage. How does one calculate their values?

Three-terminal regulators are simple and convenient to use ''on paper'' but there are one or two drawbacks to consider, especially at the higher voltages/currents you are hoping to provide.

I'm not sure that stripboard would be a suitable medium on which to construct a reliable high current design. You might consider assembling with old-fashioned tag strips or ''turret board'', using heavy gauge solid core wires for interwiring, which should be kept as short as possible. A simple point-to-point design will cope admirably with higher currents as well as having a higher mechanical strength than anything you could make with stripboard.

The output ratings of your transformer are not quite clear, so here are a few points to bear in mind. Transformer manufacturers normally rate secondary voltages and currents assuming only a simple *resistive* load is used at the maximum permissible current of the transformer. This has two implications: first, due to its regulation the secondary voltage will rise at *lower* currents, so allowances must be made for this (when specifying the rectifier and smoothing capacitor voltage ratings).

Second, although makers specify ratings assuming a *resistive* load, in a full-wave rectified power supply the load is more complex than that – we are placing rectifiers and a very large smoothing capacitor across the secondary winding. The effect is that we find currents flowing in the secondary circuit higher than those found in an ordinary resistive circuit.

As a good rule of thumb, the transformer secondary current figure should be derated by about 40 per cent in such cases. A 5A transformer (for example) should only be expected to safely supply about 3A total load current in a full-wave power supply, see Fig. 1.

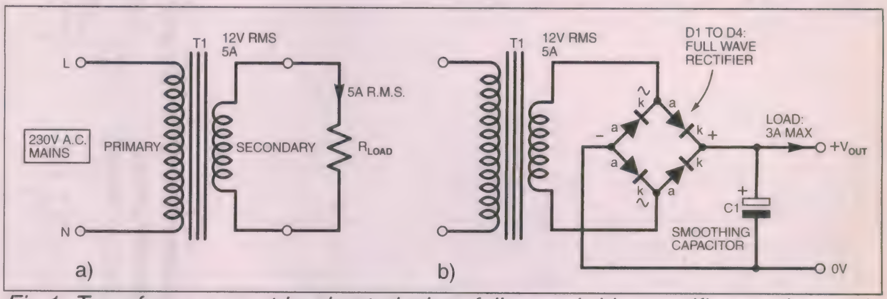


Fig.1. Transformers must be derated when full-wave bridge rectifiers and smoothing capacitors are used. Makers' ratings usually assume a resistive *load.*

The term *root-mean-square* (r.m.s.) is applied to alternating voltage and current values, including the ratings of transformers. Root-mean-square values are useful as a way of comparing a.c. voltages and currents against d.c. equivalents.

An alternating voltage of say 12V r.m.s. placed across a fixed resistor will produce the same heating effect (power dissipation) as would a voltage of 12V d.c. (Multiplying the r.m.s. value by 1·414, the square root of 2, tells us the *peak* value of the alternating voltage.)

In the example of Fig. 1, the transformer shown will have a manufacturer's secondary voltage rating of 12V r.m.s. at 5A output. The voltage will tend to increase when the load curent is reduced, and a value of nearer 16V or so off-load would not be surprising.

Furthermore, that 5A secondary current is only valid when a simple resistive load is used as shown. Ideally your own transformer must be capable of providing 8·3A on full load, but to be realistic you are limited by what you can buy off the shelf or happen to have available anyway.

Regulations

Looking at the regulator itself, a guaranteed way of destroying such a device is to exceed the input-output voltage, so well done for highlighting this parameter! Incidentally my National Semiconductor data book specifies 40V as the maximum input-output differential.

This input-output voltage rating is the maximum difference in voltage which is

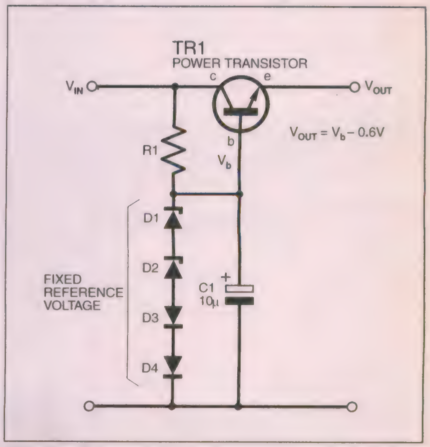


Fig.2. A simple pre-regulator may help avoid excessive input-output voltage appearing across variable regulators. D1 and D2 are the Zener diodes.

permitted between the input and the output pins of the regulator. A bench power supply is likely to be subjected to some rough treatment, and it is quite easy to overlook the implications of this rating.

If the input voltage is known to be, say, 30V d.c. maximum then if the power supply output was shorted to 0V, the entire voltage will appear across the device. No harm will be done at 30V and the device will current limit.

If for some reason the input voltage rises to say 50V or more then clearly the input-output voltage would be exceeded and you risk destroying the device. Hence you ought not to directly use your transformer to produce a variable design with the LM338. One work-around is to use a form of "pre-regulator" which clamps the input voltage to a safe fixed value.

A simple Zener diode with an external pass transistor might be suitable (see Fig. 2) provided the tolerances are not too wide. You can combine Zener diodes and also "jack up" the voltage with ordinary forward-biased rectifiers using some trial and error if necessary. The output voltage seen at the transistor emitter (e) is one diode drop lower than that appearing at the base (b). Remember to select a transistor with a high enough collector current rating.

Doing your Sums

Your second question relates to the calculation of the resistor values. The formula is just a derivation of that for a potential divider. A typical three terminal variable regulator is shown in Fig.3.

A reference voltage V_{ref} is developed across the resistor R1 and by applying ordinary potential divider theory we can say:

$$V_{ref} = \frac{R1}{(R1 + R2)} \times V_{out}$$

$$\text{so } V_{out} = \frac{V_{ref}\,(R1 + R2)}{R1}$$

$$\text{or } V_{out} = V_{ref}\,(1 + R2/R1)$$

A value of 1·25V is a nominal value for the reference voltage. A value of 240 ohms is typically used (220 ohms will be fine) for R1, which allows about 5mA to flow through the resistor chain. A further 50μA (I_{adj}) flows out of the adjustment pin to 0V, but for most purposes it is not often necessary to consider this any further.

One final aspect of your proposed power supply is that you should allow for a suitable heatsink on the LM338, and it is here where the plan may fall down. Whilst the device is protected from thermal overload, it does mean that if you are to enjoy maximum current outputs then some substantial heatsinking will be required, otherwise the device will thermally-limit in extreme cases.

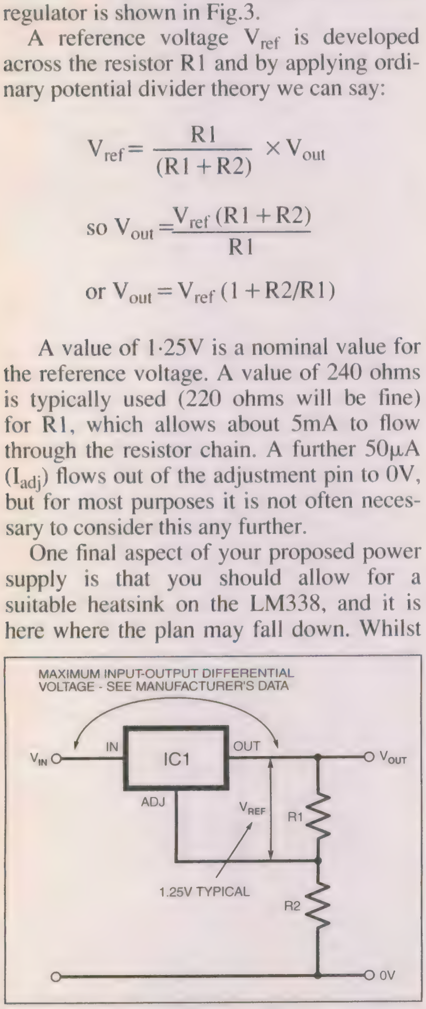

MAXIMUM INPUT-OUTPUT DIFFERENTIAL VOLTAGE - SEE MANUFACTURER'S DATA
V_{IN}
IN
IC1
OUT
V_{OUT}
ADJ
V_{REF}
R1
1.25V TYPICAL
R2
0V

Fig.3. Calculating the output voltage from a variable voltage regulator. A typical value for V_{ref} is 1·25V.

Unfortunately, it is not possible to calculate the heatsink's thermal resistance until the power dissipation of the regulator is known. It is precisely because of thermal efficiency problems with such designs that switched-mode power supplies are preferred.

Electret microphones

Last month I described the composition of a typical electret microphone capsule, and went off in search of the mysterious transistor contained within. My thanks to ***Barry Taylor*** who adds further interesting comments and describes the electret effect in more detail:

I would guess that the transistor labelled K596 is probably a 2SK596 as I have frequently come across devices from the Far East that omit the first two characters (esp. on TO92 packages). K indicates an n-channel f.e.t. or MOSFET. You say that Motorola suggest a 2N5484 but according to my sources this is not a MOSFET but an n-channel j.f.e.t. I regret that I can't find any listing of a 2SK596 though.

You make no mention of the meaning of the word "electret", which could imply that the variation in capacitance directly produces the a.f. output. This is not strictly true even though it is easily demonstrated that tapping a length of screened cable connected to a high input impedance amplifier will produce a noise on the output. Electret material, which is a fluorocarbon polymer, can be given an electrostatic charge which lasts almost for ever.

If an electret material is used as the diaphragm (with one side metallised of course) in a microphone together with a rigid back plate then a capacitor is formed with constant charge Q. Sound pressure will cause the diaphragm to vibrate and thus the capacitance to vary. Since the charge is constant and as V = Q/C the result is a voltage proportional to the sound pressure.

The f.e.t. simply acts as an impedance converter and this must be (as you found only one resistor) configured as a common-source amplifier which, given a suitable j.f.e.t., doesn't need a source resistor if the input signal is small. So, I would guess that the resistor you destroyed was a gate to source resistor with a value of possibly tens of megohms. I'd be interested if anyone can confirm this surmise of mine about the f.e.t.

Professional condenser microphones generally do not use electret materials. The diaphragm is a metallized polymer film polarised by 48V d.c. via a 1G ohm resistor which results in a virtually constant charge. The polarising voltage is fed to the microphone via a "phantom" power supply from the mixer which also powers the built-in impedance converter.

It is true that the "2N" or "2S" is commonly omitted from the nomenclature printed on the device. My first thought was also that the mysterious transistor was a 2N or 2SK type but further research drew a blank (as you found yourself). A device type KSK596 is listed by Motorola but there was no data available. I rechecked the National Semiconductor web sites as described last month, and this bounced over to the Fairchild web site.

I finally obtained the data sheet which states "N-Channel RF amplifier" so I'm none the wiser. In retrospect I would concur that it's probably a junction f.e.t. but hopefully I can be forgiven my near miss!

Back to my groaning bookshelves and my *Dictionary of Electronics* defines "electret" as the electrical analogue of a permanent magnet. It is a dielectric body with separate electric poles and a stable existence. The metallic disk I alluded to is a synthetic dielectric film, metallised on one face.

I agree that there is a dearth of information about electrets, which is what prompted the article to start with, but a quick look at several microphone manufacturers' web sites did reveal interesting information including more on "phantom" power supplies. Try **www.sennheiser.com** and **www.shure.com**. I also found an enthusiastic web page on **www.mpage.demon.co.uk/electret.htm**. Thank you for filling us in with the extra information!

Quick cap check

I would like to know how to check a capacitor both out of board and in-board, to determine whether the capacitor is leaking or otherwise faulty.

So asks ***Siva Pathmanathan*** (by E-mail). It is straightforward to check larger capacitors just by using an ordinary multimeter set to a high resistance range. A moving coil meter is possibly better for this experiment.

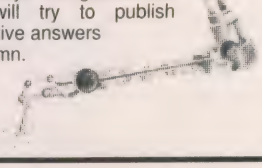
By clipping the test leads to an electrolytic capacitor, the resistance reading will briefly be seen to fall as the capacitor will charge up through the meter's internal battery. The meter's *black* lead is in fact positive (the reverse is true on digital multimeters, which have a much higher impedance), so by touching this to the capacitor's positive lead, the needle "blip" will be seen.

With lower value capacitors, probably the best you can hope for is to check for a shorted capacitor, which will show as a low resistance.

Checking a capacitor in-situ isn't reliable because other components in the same circuit may affect the readings. In any case, definitely do ***not*** check while power is applied to the circuit, and remember to *discharge the capacitor to start with, using a low-value* resistor for larger electrolytic capacitors if necessary.

CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail **alan@epemag.demon.co.uk.** Please indicate if your query is not for publication. A personal reply cannot always be guaranteed but we will try to publish representative answers in this column.



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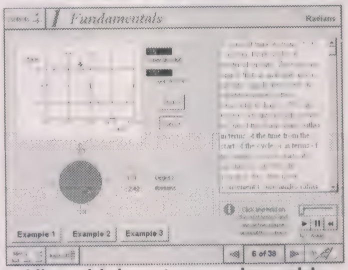

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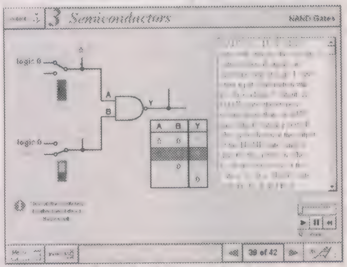

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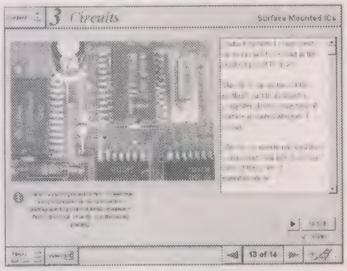

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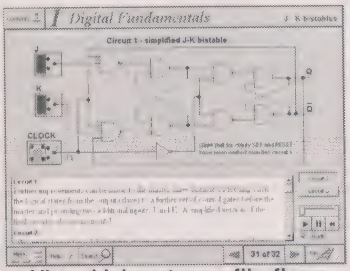

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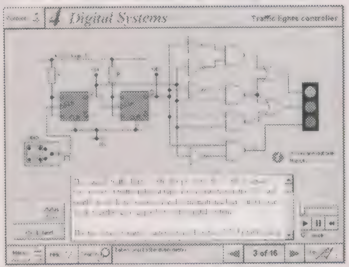

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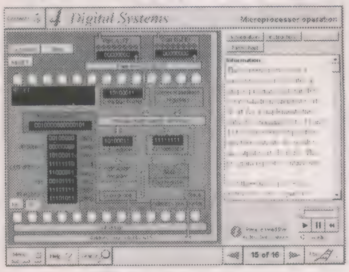

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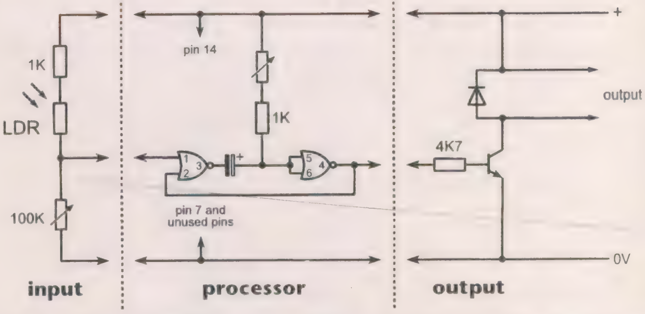

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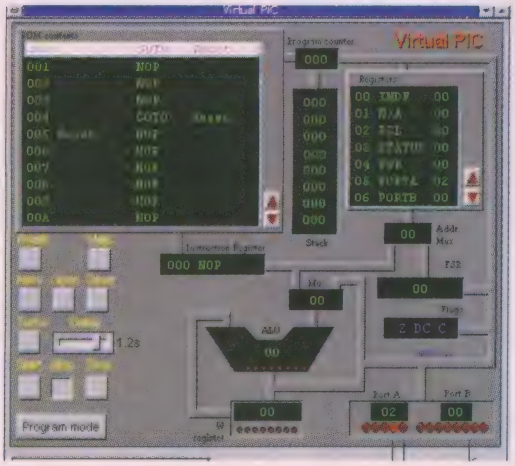

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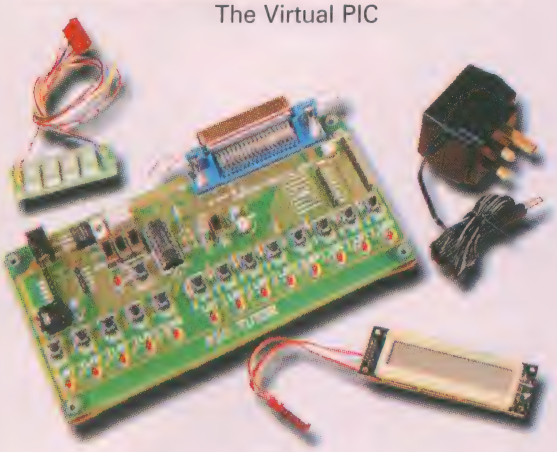

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TIME AND DATE GENERATOR

TONY HART

Capture real time events on your security monitor screen or add them to your home videos with this PIC time machine.

WITH the availability of cheap video cameras more and more people are adding surveillance cameras to the exterior and interior of their homes. Cameras connected to a video recorder will record all sorts of amusing and sometimes nefarious activities, and usually it is useful to know the precise time that these events occur.

Designed for home use, this project adds time and date information to a multicamera home video security system. The Time and Date Generator inserts a steady and easily readable time and/or date caption onto any composite video signal. The time and date information being displayed at the bottom of the screen.

It also has the optional facility to display a camera number (1 to 8) provided from an external camera selector by inputting a 3-bit camera address. This will allow the user to know which one of eight cameras is currently active.

Although originally intended for adding time and date information to security cameras, it is equally useful for adding time and date to home videos, for those who have not got this capability built into their video camera.

This design is based on a PIC16C84 which performs the real time clock function and display character generation.

CIRCUIT OVERVIEW

A system block diagram of the Time and Date Generator is shown in Fig.1. The full circuit diagram is given in Fig.3.

The circuit is based around the PIC16C84 microcontroller IC3 (from here-on referred to as the PIC). The PIC has three main functions, namely to maintain the real time clock, to generate all the character pixel data that is necessary to display up to 32 characters at the bottom of the screen and finally to control when the character pixels are displayed.

Each character is composed of an eight pixel by seven screen line matrix. For this number of characters the PIC is not fast enough to directly superimpose the required display data onto the composite video signal coming from the video source. Instead, the PIC loads the character display data on a line-by-line basis into an external RAM chip IC5 in the period of time immediately after the frame sync.

One line is written per frame, so that every seven frames the RAM is fully updated. At the end of this period the RAM contains all the data required to produce a 32-character by 7-line display on a TV/monitor screen.

Between line 256 and 291 the PIC releases control of the RAM chip (IC5) to a fast gated oscillator, IC2a, which clocks the previously stored lines out of the RAM, each bit modulating the input composite video signal on the fly. The gated oscillator is repeatedly synchronised to start a few microseconds after each line sync, therefore enabling the output display to appear steady on the monitor screen.

REAL TIME CLOCK (RTC)

The PIC software implements a real time clock (RTC) function. The real time clock data is stored in registers SEC, MIN, HRS, DAY, MTH, YRS and YRSH. The DAY register is incremented to the value determined by the MTH and YRS registers according to the verse:

"30 days hath September, April, June and November. All the rest have 31 except February alone which has 28, except 29 during a leap year."

A leap year is normally any year divisible by four except if the year ends in 00 when it also has to be divisible by 400 to be a leap year. So, for example, the year 1900 was not a leap year, but the year 2000 will be.

The RTC only operates when the PIC is powered, either from the main 12V source or from a battery back-up.

RTC ACCURACY

The RTC relies on the PIC's crystal controlled clock for timing. For this application the PIC's 8-bit timer TMR0 is set to operate in conjunction with the 8-bit prescaler to form a 16-bit counter which is incremented each instruction cycle. This is every 0·4µs with the 10MHz crystal specified (X1).

The PIC maintains the real time clock by counting the TMR0 overflows. When incremented every instruction cycle TMR0

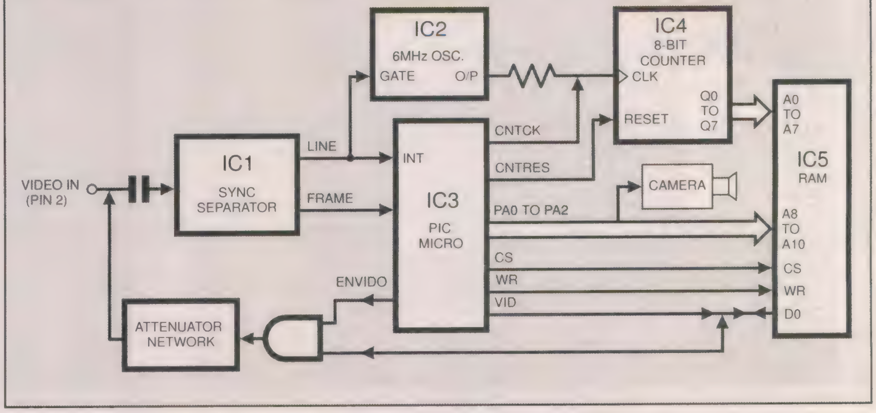


Fig.1. System block diagram for the Time and Date Generator.

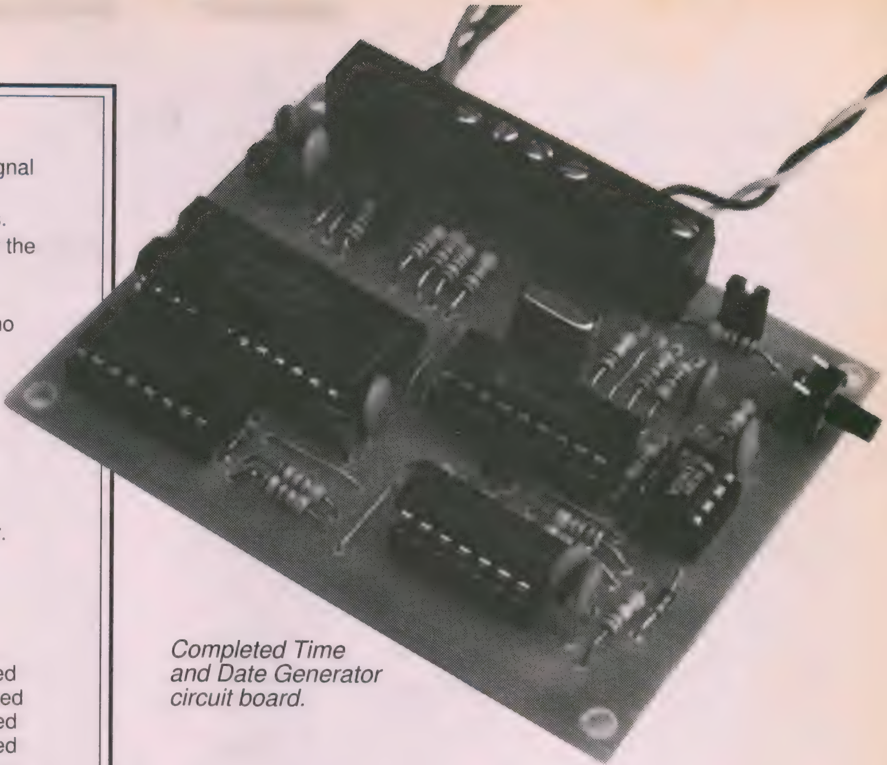
SPECIFICATION

- Adds time or date or both to a composite video signal (NTSC, PAL and SECAM video signals).
- Selectable character height of 5 ,10,15 or 20 lines.
- Selectable line display from line 256 to line 291 at the bottom of the screen.
- Inverse or normal video display.
- Day and month display are swapable for those who prefer the American standard.
- Display external camera number from 1 to 8 via external 3-bit input.
- Display symbol with camera number via external 1-bit input.
- Leap year correction.
- Battery back-up if required.
- Accurate Real Time Clock with a software trimmer.
- Year 2000 compliant.

DISPLAY EXAMPLES

Examples of the display are as follows :-

23:59:33	23/02/1998		time/date displayed
23:59:33	02/23/1998		day/month swapped
23:59:33	23/02/1998	C-5	camera 5 displayed
23:59:33	23/02/1998	C/5	camera 5 displayed symbol change
23:59:33			time only
	23/02/2001		date only


Completed Time and Date Generator circuit board.

will overflow every 0·4×256×256ms or 26·2144ms. At each overflow, a counter called CLOCK1 is incremented and every 38 CLOCK1s the clock's second counter (SEC) is incremented.

However, one second is not exactly 38 CLOCK1 periods, it is actually equal to 1 sec/26·2144ms or 38·147 overflows. So incrementing SEC every 38 CLOCK1 periods will produce a fairly inaccurate real time clock as the inaccuracy will be 0·147×CLOCK1 or 3·8ms error every second, which translates to 332 seconds per day error – not very good.

IMPROVED ACCURACY

Luckily, the computing power of the PIC allows some easy manipulation to improve the accuracy. Consequently every seven seconds an extra CLOCK1 is added so that 39 overflows are counted. So every seventh SEC count there are 38×7+1 or 267 overflows. This translates to 267 × 26·2144ms = 6·9992448 sec. This reduces the inaccuracy from 332 sec/day to about 9·3 sec/day, which is a big improvement.

To improve the accuracy even more, every 35 of the seven second periods another CLOCK1 is added. So every 7×35 or every 245 seconds the PIC actually counts 35×6·9992448+0·0262144 seconds=244·99978secs. This reduces the inaccuracy from 9·3 sec/day to about 0·1 sec day.

These numbers assume that the 10·000MHz crystal oscillator providing all the timing is running at exactly zero parts per million (ppm) error. This is highly unlikely and with tolerance, temperature and ageing effects the crystal frequency will be more likely to be within ±100ppm unless a trimmer is incorporated.

An error of 100 ppm translates to an error of about 8·6 seconds per day. So unadjusted, the real time clock is going to keep time to better than 10 seconds per day or say five minutes per month, providing the crystal oscillator is running at 10MHz ±100ppm. A method of trimming has been included in the software to trim the real time clock by up to plus or minus nine seconds per day.

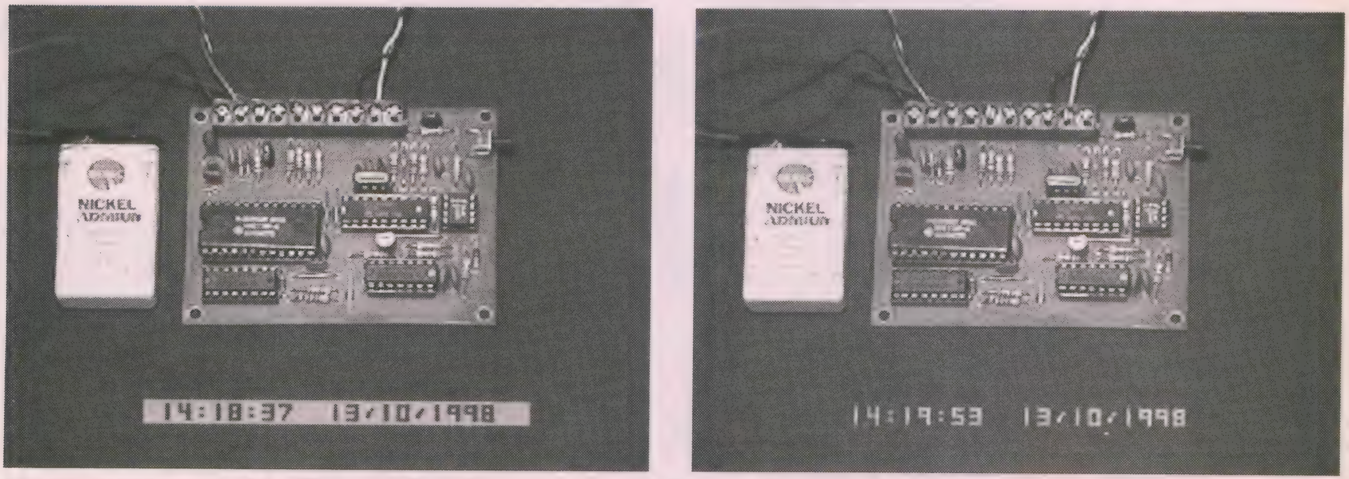
TIME STORE

Every time any of the clock counters, e.g minutes, hours, day, month or year changes, its value is stored in the EEPROM of the PIC, so that should the power supply fail the time will be reset to what it was before the power failure, except that the seconds count will be reset to zero. There is a slight problem here, in that the data EEPROM of the PIC has a limited lifetime of typically one million write cycles.

For the hours counter, one million writes relates to 114 years of use. But for the minutes counter it relates to only 1·9 years of use which means that the minutes memory location in EEPROM will become unreliable in just under two years time.

To overcome this the minutes value is stored in the EEPROM address calculated from the year ANDed with 1F hex and is therefore distributed over 32 EEPROM locations, which increases the EEPROM lifetime from 1·9 years to about 60 years. (Let me know in 60 years if my calculation is correct.)

In practice it is recommended that a rechargeable back-up battery is used so that the power never fails.



Monitor screen shots of the Time and Date Generator module showing two forms of displaying the time and date readout. Note the rechargeable back-up battery.

DISPLAY CHARACTER GENERATOR

The character format for the numbers 0 to 9 is shown in Fig.2. Characters are composed of a simple 8-dot by 7-line matrix (lines L0 to L6). Each numeral is six dots or pixels wide with a blank dot either side, producing two spaces between characters.

In normal video the top line (L0) and a bottom line (L6) are always blank so this effectively produces an 8-dot wide by 5-line high matrix which is quite readable. If the inverse video option is enabled the top and bottom lines appear white, so producing the effect of an 8-dot × 7-line matrix.

The software allows each line of dots to be output once, twice, three or four times providing actual character height of 5,10,15 or 20 lines. The user can therefore select the most easily readable format for their particular screen.

Because the PIC is too slow to insert the time/date pixels directly onto the composite video signal, the character data is written by the PIC to the RAM chip (IC5) during the first 256 lines after the frame sync at a rate of one line per frame. The RAM chip used is actually a 2048 × 8-bit device, but only one bit of each 8-bit byte is used here. Each of the five lines of the display plus the spacing lines at the top and bottom of the display (seven lines in total) are therefore clocked into the RAM during a seven frame period.

The bottom 8-bits of the RAM address A0-A7 come from a 4040 binary counter (IC4) and the top 3-bits (A8,A9,A10) are driven directly from PORTA of the PIC (IC3). The PIC can control the RAM address by initially clearing and then clocking the counter via PORTB pins RB5 and RB3 respectively.

The PIC can therefore write up to 256-bits of data or pixels to up to eight blocks of RAM, where each block contains one line of bits to display. This allows up to 32 characters to be displayed across the screen, although the normal maximum used here is 28 characters.

However, during configuration up to six extra characters are required to be displayed and to allow this each character is displayed with only one space between characters. This bunching up allows up to 36 characters to be displayed, but with slightly less legibility.

PIXEL LOOK-UP TABLE

The PIC is responsible for compiling and generating the character pixels to store in the RAM. The following is an example that shows how each pixel of the character "2" is formed and Table 1 shows an extract from the actual software.

On entry to the **wrramblk** routine the value to be displayed, in this case "2", is in the high nibble of the **W** register. This is the same as the value to be displayed multiplied by16 (2 × 16 = 32 decimal = 20 hex). The low nibble is cleared with the **andlw 0F0h** instruction and then the pixels are obtained from the look up table in **segment**.

The **W** register is stored in memory location **OFFSET** which is then divided by 2 by the **rrf OFFSET** instruction. This is now the equivalent of the value to be displayed multiplied by 8 and gives the offset to any number in the look up table.

```
L0
L1 000000  00  000000  000000  00  00  000000  000000  000000  000000  000000
L2 00  00  00      00      00  00  00  00      00          00  00  00  00  00
L3 00  00  00  000000  000000  000000  000000  000000     00   000000  000000
L4 00  00  00  00          00      00      00  00  00    00    00  00      00
L5 000000  00  000000  000000      00  000000  000000   00     000000      00
L6
```

Fig.2. Character format for the numbers 0 to 9.

To this is added the number stored in **POINTER** and copied to the program counter **PC**. The value is then returned in **W** and copied to the memory location **SHIFT**. **POINTER** is effectively the current line of the character.

For example, if line 5 of the character "2" is required, then the value added to the **PC** is as follows:

Character in W	25h	the MSB "2" is to be displayed
andlw	F0h	clear the low nibble
result	20h	
div by 2	10h	this is the character offset
add POINTER	05h	line number
result	15h	this is added to the PC

15h is added to the Program Counter and the PC is changed to address + 15h and executes the following instruction

retlw b'01111110'

therefore returning with the value 01111110 in the **W** register

In summary

If pointer = 00 then **retlw b'00000000'** is executed
If pointer = 01 then **retlw b'01111110'** is executed
If pointer = 02 then **retlw b'00000110'** is executed
If pointer = 03 then **retlw b'01111110'** is executed
If pointer = 04 then **retlw b'01100000'** is executed
If pointer = 05 then **retlw b'01111110'** is executed
If pointer = 06 then **retlw b'00000000'** is executed

Table 1: Example of the use of a Look-up table for character generation

```
wrramblk
          andlw   0f0h                  ;select top nibble
          call   segment
          movwf   SHIFT
          etc

          ORG     0300h
segment                                 ;w =  16 x value
          movwf   OFFSET                 ;save in OFFSET
seg1
          movlw    03h
          movwf    PCLATH               ;select 3rd page for computed goto
          rrf      OFFSET,w             ;w = CHAR x 8
          andlw    b'01111000'          ;mask in good data
          addwf    POINTER,w
          addwf    PCL                  ;jump to OFFSET and return value

PC address
00        retlw    0
01        retlw    b'01111110'      ;0
02        retlw    b'01100110'
03        retlw    b'01100110'
04        retlw    b'01100110'
05        retlw    b'01111110'
06        retlw    0
07        retlw    0
08        retlw    0
09        retlw    b'00001100'    ;1
0A        retlw    b'00001100'
0B        retlw    b'00001100'
0C        retlw    b'00001100'
0D        retlw    b'00001100'
0E        retlw    0
0F        retlw    0
10        retlw    0
11        retlw    b'01111110'    ;2
12        retlw    b'00000110'
13        retlw    b'01111110'
14        retlw    b'01100000'
15        retlw    b'01111110'      ** This is the value returned
16        retlw    0                   in the example above
17        retlw    0

etc
```

On returning from the **segment** routine the value in **W** is placed in register **SHIFT**. The software then shifts the eight bits (01111110) of this data, MSB first, into the main RAM chip IC5 by outputting each-bit in turn and generating a WE and CS pulse for the RAM. If inverse video is selected then all-bits are simply inverted before shifting into the RAM.

After each-bit is shifted to the RAM, the RAM address counter IC4 is incremented by the PIC (IC3) generating a clock pulse on pin RB3.

At the beginning of each line the PIC resets the RAM address counter to zero and increments the RAM address A8,A9,A10 by incrementing PORTA. In this way all the pixels are loaded into the RAM for each line of all characters to be displayed.

DISPLAY CIRCUIT

Some relevent waveforms to help understand the display circuit operation are shown in Fig.4. The PIC is interrupted every line sync and counts the number of lines following the frame sync. At the appropriate display line (lines 256–291 under software control) the PIC releases control of the RAM clock to a fast clock synchronised to the line sync.

Initially at the start of each display line the PIC resets the counter IC4 by raising and lowering PORTB pin RB5 (**CNTRES**). Then it allows the gated oscillator (IC2a) to clock the counter IC4 by simply setting PORTB pin RB3 tristate, allowing the gated oscillator IC2a to clock the counter IC4 via resistor R8. The counter increments the RAM address and the RAM outputs the previously stored data for the line of the display controlled by the upper three address lines set by PORTA pins RA0, RA1 and RA2.

The counter IC4 increments 256 times until counter output Q9 goes high which pulls the clock input high via diode D2. This inhibits any more of the gated oscillator clocks until the counter is reset at the beginning of the next line. Without this mechanism the counter would overflow and the line could be partly displayed again.

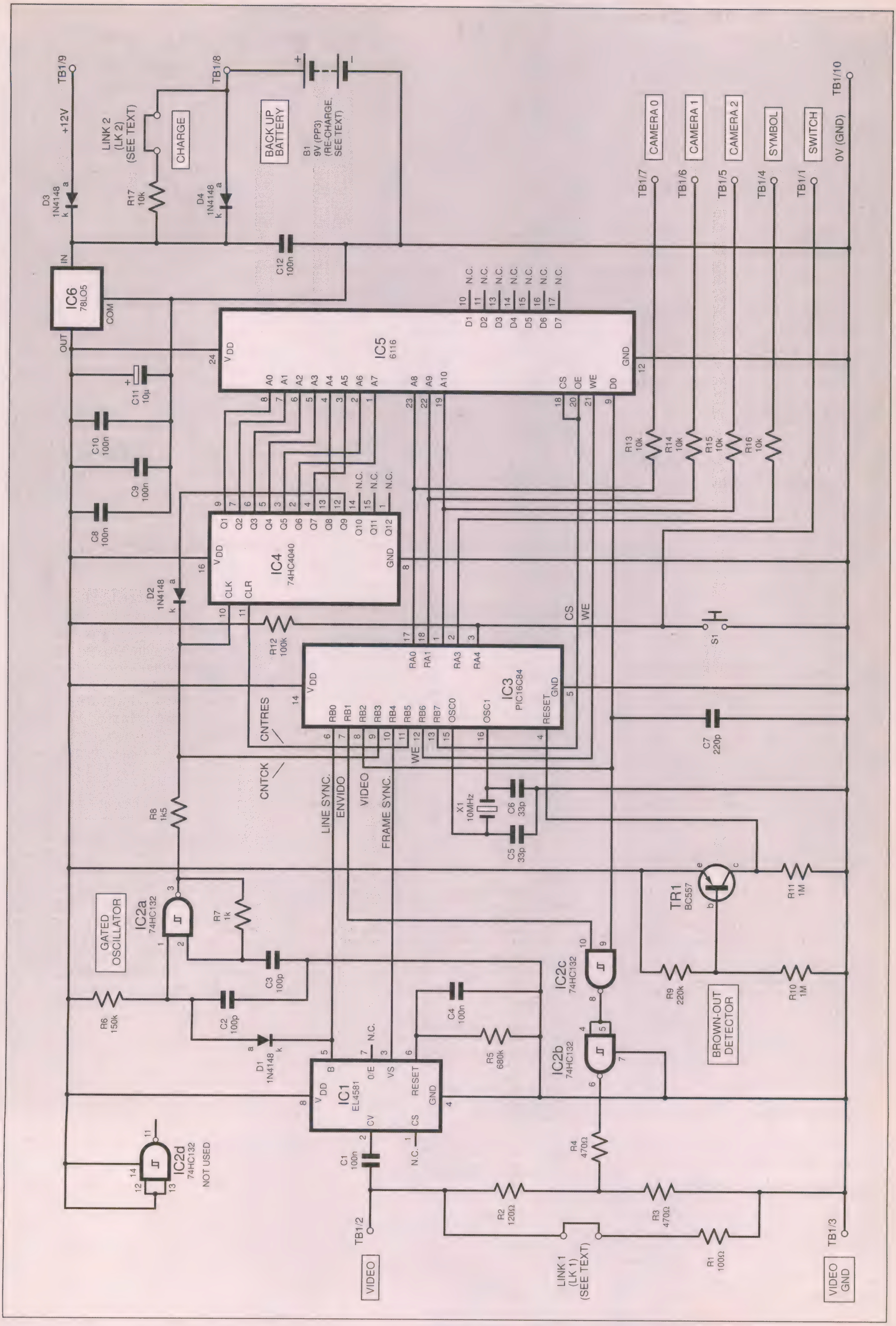


Fig.3. Complete circuit diagram, including back-up battery, for the Time and Date Generator.

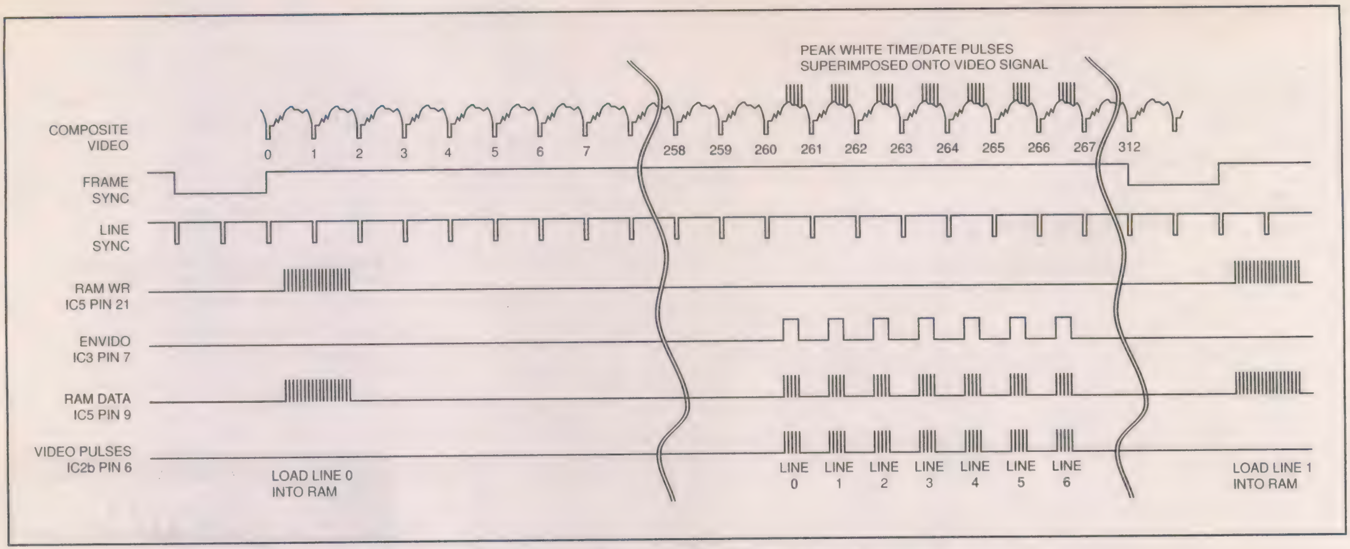


Fig.4. Example waveforms for the Time and Date Generator circuit.

RAM OUTPUT

The RAM output contains a few glitches due to the address counter IC4 being a ripple counter. This means that the higher Q outputs change state later than the lower outputs after a clock input resulting in a temporarily incorrect address being presented to the RAM address inputs. This effect is overcome by adding capacitor C7 which reduces the width of the glitches to a level that is not discernible on the monitor or TV screen.

The deglitched RAM output is gated by an active high signal called ENVIDO from the PIC pin RB1 which goes high only during the lines that are to be used to show the display. These signals are ANDed together by IC2c and IC2b. The output of IC2b then overwrites the existing video signal. The ENVIDO signal is timed so as to prevent any modulation of the input video signal during the sync period.

Resistors R3 and R4 form a potential divider to reduce the gate output voltage to 2·5V. This is then added to the video signal by resistor R2, producing a peak white signal level. The PIC does this for each of the seven lines that make up the display characters resulting in a steady display of the time and date. The character height can be selected by making the RAM output each of the character lines 1,2,3 or 4 times.

This design is simple but has some drawbacks. For example, the time/date data simply superimposes a peak white level on the composite video signal. Therefore, if peak white is currently being displayed it is possible that parts of the display will not be discernible from the picture information. However, this can usually be overcome by adjusting the line display position during setting-up and has rarely been found to be a problem. To enclose the graphic output and insert the data would require the design to be much more complicated.

SYNC SEPARATOR

The video signal input (at terminal strip TB1 pin 2) is capacitively coupled by capacitor C1 to the Video Sync Separator chip IC1. This chip can be either an LM1881 or the slightly improved EL4581, both devices being pin compatible.

The only external components required for the video sync separator chip to function are resistor R5 and capacitor C4. C4 is not really required for use with the EL4581 so can be omitted if required.

Here the video sync separator produces active--low frame and line sync signals extracted from the composite video input. Both these signals are passed to the PIC microcontroller (IC3) and the line sync is used as an interrupt. The line sync signal is also used to synchronise the gated oscillator circuit IC1a to enable a steady display to be obtained.

GATED OSCILLATOR

The Gated Oscillator is based around the 2-input Schmitt NAND gate IC2a, see Fig.3. The oscillator is formed by feedback resistor R7 between the gate output (pin 3), input (pin 2) and capacitor C3. The gate oscillates at approximately 6MHz to 7MHz when the other input (pin 1) is high.

However, this input (pin 1) is pulled low every line sync by the sync separator line output via diode D1, which discharges capacitor C2 causing oscillation to be stopped. The active-low line sync pulse is only about 1µs wide, so after the pulse returns high, capacitor C2 starts charging again, via resistor R6. After approximately 10µs the voltage across C2 exceeds the gate logic 1 input positive threshold and the gate starts to oscillate again.

This arrangement synchronises the gate output to the line sync and starts the oscillator 10µs after the line sync. This time determines the display start point from the left-hand edge of the monitor screen. The frequency of oscillation determines the apparent width of the display on the monitor screen. If it is found necessary to adjust these values to best fit the display into the monitor screen then adjust resistor R6 to control the start position and R7 to adjust the display width.

BROWNOUT DETECTOR

The brownout detector circuit, made up of transistor TR1 and resistors R9, R10 and R11, will detect when the 5V supply begins to collapse and apply a hard reset level to the PIC. This is necessary in this circuit to prevent erroneous values being written to the data EEPROM when the power supply is removed.

Without the brownout detector it is not uncommon to get rubbish written into the EEPROM, resulting in incorrect time and date data being stored.

POWER SUPPLY

The circuit is designed to operate from the same +12V supply as the camera but will actually operate from about +7V to +30V. The lower limit depends on the type of +5V voltage regulator (IC6) used.

A low drop out version will allow the supply to approach +5volts. The upper input voltage is really only imposed by the maximum regulator input voltage. The current consumption is only about 10mA.

The design also allows for a back-up battery to be used which may, if required, be a rechargeable type. It is recommended that a PP3 NiCad type be used.

If the normal supply is 12V and link LK2 is fitted, the battery will be trickle charged at approximately 0·3mA via resistor R17. If a higher supply is used then the value of R17 may need to be increased to ensure that the rechargeable battery is not over charged, although the value specified is probably sufficient for an input voltage of up to 20V.

Note that if a supply of less than the battery voltage is used, then power will be supplied from the back-up battery and not the main power source!

EXTERNAL CAMERA INPUT DATA AND SYMBOL

In a multiple camera system, where the image shown on the monitor can come from a video selector, it is useful to be able to display the number of the camera in use on the screen. This design allows a binary number input to terminals TB1 pins 7, 6 and 5 (bits 0, 1, 2 respectively) to be displayed as a decimal number on the screen. The actual decimal value displayed is the inputted binary plus one, in other words, if the binary input is 0 then 1 is displayed, and if the binary input is 7, then 8 is displayed on the screen.

The three input bits are read during the space of time after the PIC loads the RAM and before the gated oscillator causes the RAM to superimpose data onto the video data. During this period PORTA pins RA0, RA1, RA2 and RA3 are changed to inputs and all the bits are read via input resistors R13 to R16.

Additionally, the input to TB1/4 alters the symbol between the "C" and the camera number. This can be used to indicate an external event or simply be set for preference.

Terminal (TB1)				Display
4	5	6	7	
0	0	0	0	C – 1
0	0	0	1	C – 2
0	0	1	0	C – 3
0	0	1	1	C – 4
0	1	0	0	C – 5
0	1	0	1	C – 6
0	1	1	0	C – 7
0	1	1	1	C – 8
1	0	0	0	C / 1
1	0	0	1	C / 2
1	0	1	0	C / 3
1	0	1	1	C / 4
1	1	0	0	C / 5
1	1	0	1	C / 6
1	1	1	0	C / 7
1	1	1	1	C / 8

A logic 0 is any voltage less than 2·5V

A logic 1 is any voltage greater than about 2·5V up to 12V

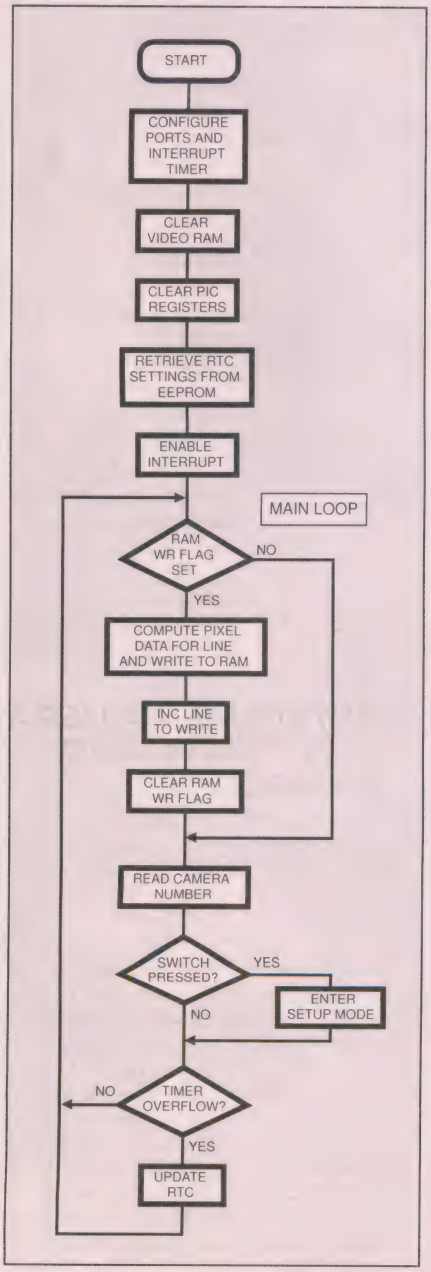


Fig.5. Setup and main loop initialisation flowchart.

The camera number display can be disabled if not required during setting up with the F6 setting.

SOFTWARE

The PIC program for the PIC16C84 has been written using MPASM, but may easily be converted to TASM assembler format.

Software for the Time and Date Generator is available on a 3·5in. PC-compatible disk from the *EPE PCB Service*. The software is *free* but there is a nominal postage and handling charge. If you have access to the Internet, it can be downloaded free from our web site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/timedate**.

See *Shoptalk* page for details of how to obtain a ready-programmed PIC16C84-10 microcontroller.

When programming the PIC the fuses should be set as follows:

WD on, OSC HS, CP off, PU on.

All of the PIC's memory is used except for just a few locations. The software is really too complex to discuss in any detail here, but two flowcharts are included to indicate the main functions.

The initialisation and MAIN loop of the software where a line of data is written to the RAM every frame is shown in Fig.5, the switch is checked and the real time clock (RTC) is maintained. This process is repeated continuously. Fig.6 shows what happens after each line sync interrupt and how control of the RAM is released to the gated oscillator when the display line is reached.

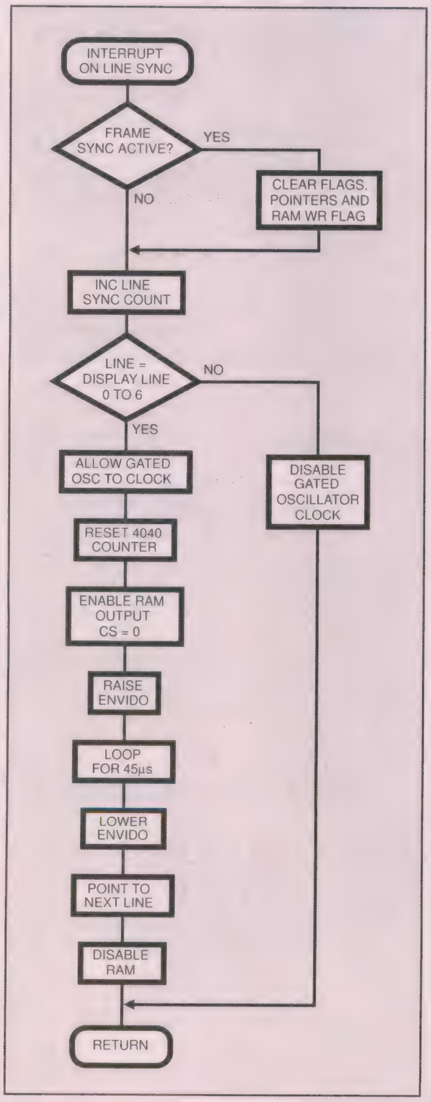


Fig.6. Simplified flowchart for the interrupt routine.

Other aspects of the software such as the character pixel generation have already been discussed in detail.

CONSTRUCTION

Details of the printed circuit board topside component layout and underside copper tracking are shown in Fig.7. This board is available from the *EPE PCB Service*, code 221.

COMPONENTS

Resistors

R1	100Ω
R2	120Ω
R3, R4	470Ω (2 off)
R5	680k
R6	150k
R7	1k
R8	1k5
R9	220k
R10, R11	1M (2 of)
R12	100k
R13 to R17	10k (5 off)

All 0·25W 5% carbon film or better

See SHOP TALK Page

Capacitors

C1, C4, C8 to C10, C12	100n ceramic disc (6 off)
C2, C3	100p ceramic disc (2 off)
C5, C6	33p ceramic disc (2 off
C7	220p ceramic disc
C11	10µ tantalum bead, 16V

Semiconductors

D1 to D4	1N4148 signal diodes (4 off)
TR1	BC557 *pnp* transistor
IC1	EL4581 or LM1881 video sync separator
IC2	74HC132 quad Schmitt NAND gate
IC3	PIC16C84-10 pre-programmed microcontroller, see *Shoptalk*
IC4	74HC4040 12-stage binary counter
IC5	6116 2K × 8 static RAM
IC6	78L05 +5V 100mA voltage regulator

Miscellaneous

S1	min. pushbutton, right-angle, p.c.b. mounting switch (press-to-make, release-to-break)
X1	10MHz crystal
TB1	10-way screw terminal strip, made up from linkable 2-way 5mm p.c.b. mounting terminal block (5 off)

Printed circuit board available from the *EPE PCB Service*, code 221; 2-way pin jumper and strip (2 off); 8-pin d.i.l. socket; 14-pin d.i.l. socket; 16-pin d.i.l. socket; 18-pin d.i.l. socket; 24-pin d.i.l. socket; coaxial cable; optional 4-way 2-pole rotary switch; multistrand connecting wire; 9V rechargeable battery (PP3); solder etc.

Approx Cost Guidance Only £28 excluding batt.

There are six bare wire links on the p.c.b. and construction should commence by soldering these in position first. These may be made from lengths of tinned copper wire or zero ohm resistors if you have any.

Solder all the other components on the board, working from the smallest up to the largest. The PIC microcontroller and the other i.c.s should all be mounted in d.i.l. sockets. Pay particular attention over the orientation of the i.c.s and diodes.

The p.c.b. terminal block may have to be slotted together to form the correct number of "ways", depending on the type purchased. Do not forget the two "jumper" links LK1 and LK2 if required, see later.

If the generator is to be mounted away from an accessible case edge, then an external switch may be included. This is effectively wired in parallel to the on-board switch S1, which may be omitted if not required.

No details have been provided for fitting the Time and Date Generator into a case, because the unit was intended to be included within the enclosure of an existing video switcher. However, if it is required to case the generator there are many suitable plastic or metal cases available and there are no special precautions that need to be taken.

Holes have been provided at each corner of the p.c.b. to facilitate fixing if required. Alternatively the p.c.b. could be fixed to another board by replacing the terminal strip with stiff wire links and soldering these down directly.

Finally, double-check for solder shorts or integrated circuits the wrong way round. When confident, wire up the generator, as shown in Fig.8 and switch on the 12V power supply. Hopefully some form of display will be shown on the monitor screen. Initially there may be a lot of dashes, indicating silly values, but after following the setting up procedure a clean display should soon result.

SETTING UP

How to connect the Time and Date Generator up to the video camera and power supply is shown in Fig.8 A typical four-camera system set-up, that allows the camera number to be displayed, is shown in Fig.9.

If video termination is required then use shorting link LK1, otherwise leave the link open. With LK1 open the input impedance is approximately 355 ohms, which will not affect the picture quality much. With LK1 fitted the input impedance is 78 ohms.

The terminal block TB1 pin functions are as follows:

Pin	Function
1	Switch
2	Composite video in/out
3	Video ground
4	Symbol input 5V = /; 0V = –. CMOS voltage levels
5	CAM bit 2 0 to 5V CMOS logic levels (max 12V)
6	CAM bit 1
7	CAM bit 0
8	Back-up battery +9V
9	+12V supply (9V to 20V)
10	Power and switch ground

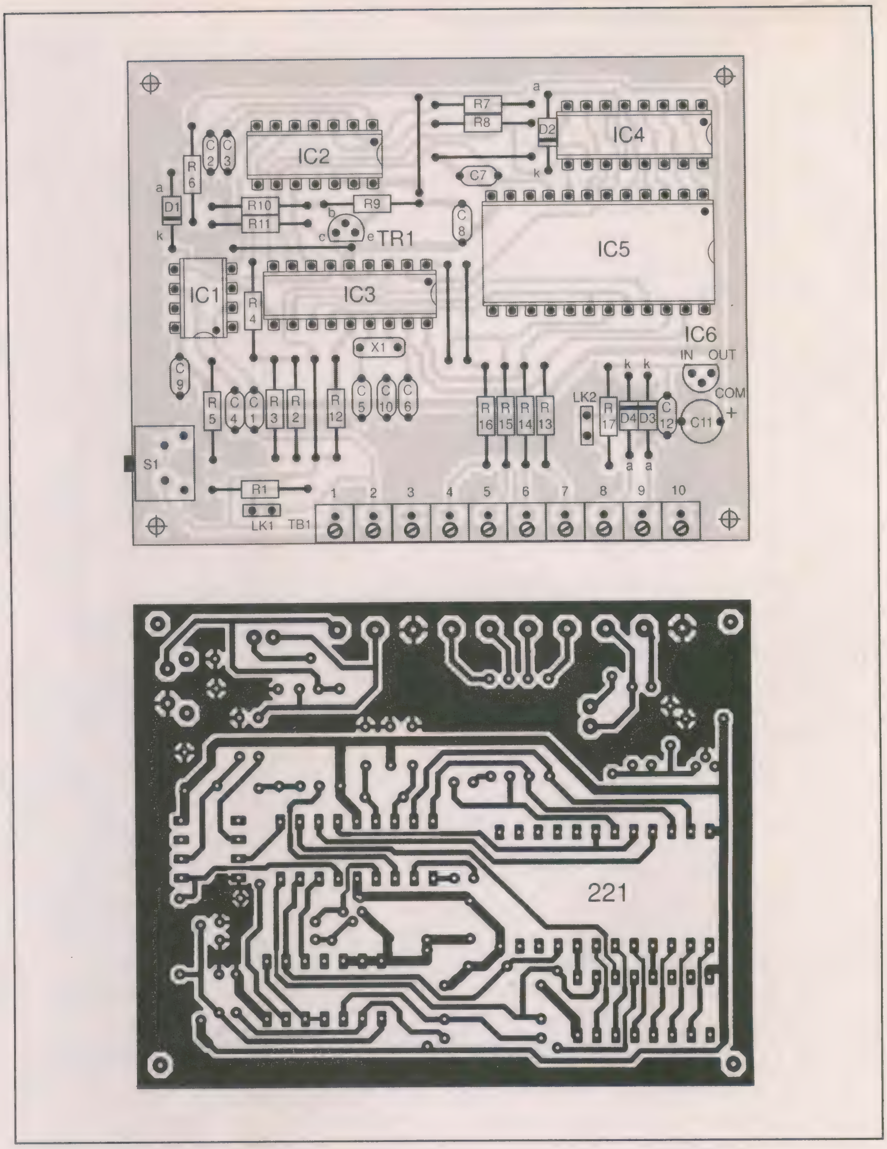


Fig.7. Printed circuit board topside component layout and full size underside copper foil master pattern for the Time and Date Generator. The right-angle 10-way screw terminal block (TB1) may have to be made up from "linkable" 2-way types.

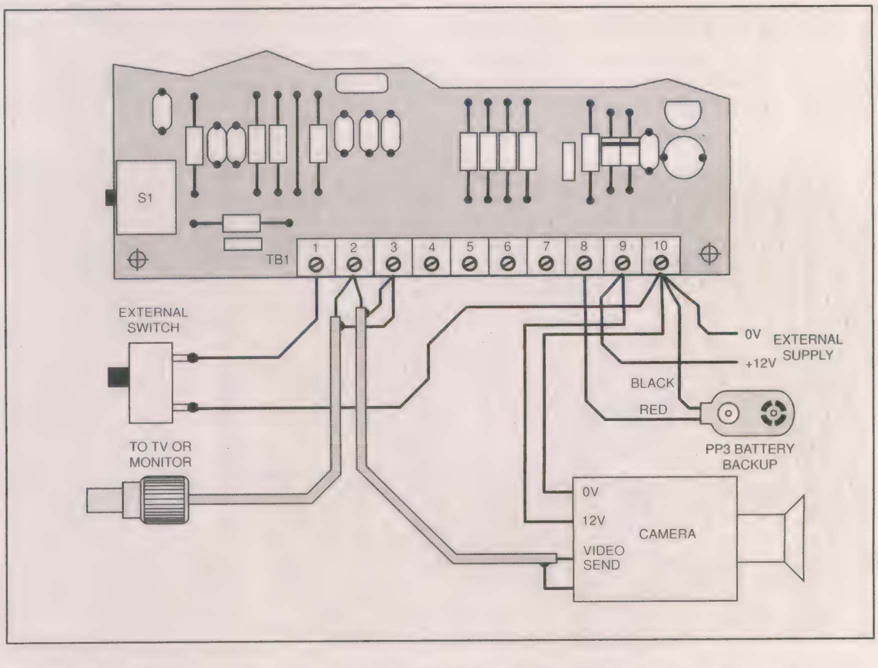


Fig.8. Typical interwiring and power supply arrangement for a single video camera setup. The external switch is optional and replaces S1 on the p.c.b.

Table 2: Function Settings

F1	Select character height of 5, 10,15 or 20 lines.
F2	Select line display from line 256 to line 291.
F3	Inverse or normal video display.
F4	Select time or date or both.
F5	Swap day and month display.
F6	Display camera number (1 to 8) and symbol
F7	Trim accuracy by up to ± 9 seconds per day.
HOURS	adjust
MINUTES	adjust
SECONDS	adjust
DAY	adjust
MONTH	adjust
YEAR	adjust

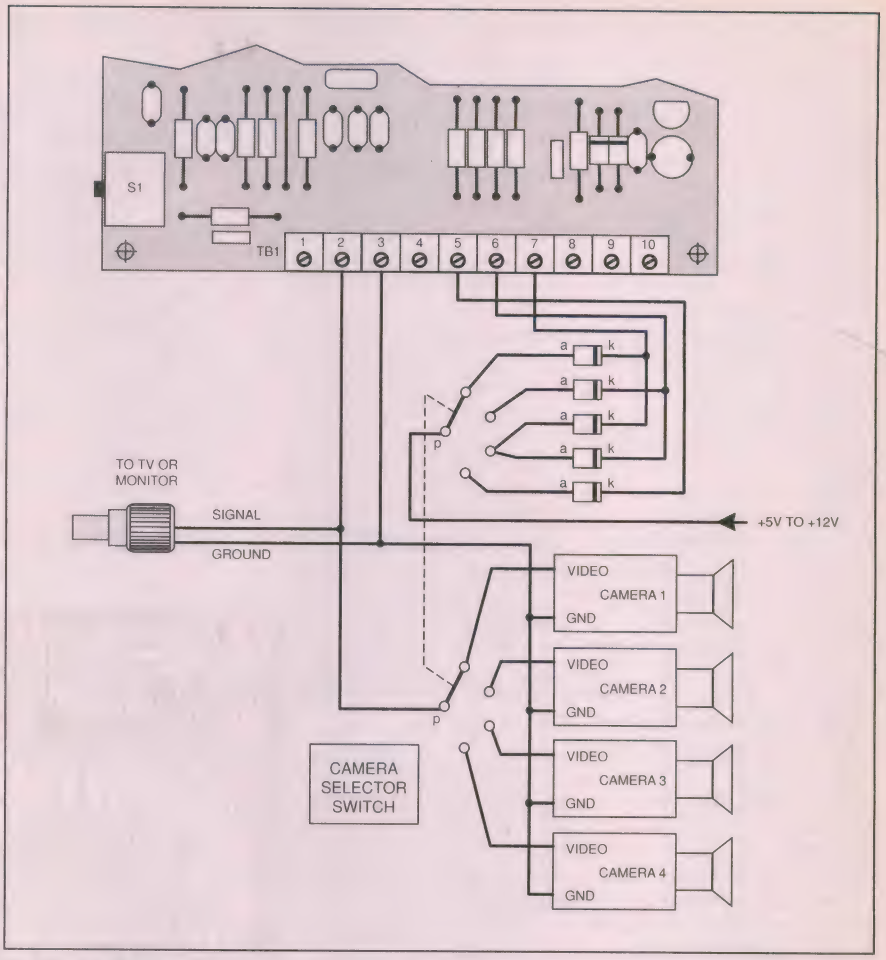


Fig.9. A typical four camera system using a 4-way 2-pole rotary switch for camera selection. The power supply connections are not shown in this diagram – see Fig.8.

The display time, date and switchable functions are all controlled by a single pushbutton switch, S1. The switch used may be S1 on the p.c.b. or it may be an external one wired between terminals TB1/1 and TB1/10 (Gnd).

When the pushbutton switch S1 is pressed for more than five seconds the display enters the set-up mode and shows "F1". A typical display being as shown below:

F1 23:59:33 23/02/1998 C-5 (function 1 selected)

Quick presses of the pushbutton then allow the required selection to be changed and displayed for that function. In the case of F1 the display height will be changed every quick press. The display is cyclic, in that after the maximum height, the next press will select the smallest height.

To get to the next function hold the push button on for five more seconds. In total there are seven function settings (F1 to F7 – see Table 2) before the time adjustment is reached. After F7 the real time clock adjustment can take place and the timer being controlled will flash. The year value increments from 1997 to 2096 before returning to 1997.

All settings and times except seconds are stored in the PIC's EEPROM such that if all power is lost then only a few settings will require changing when power is restored. A description of each of the function settings obtained by keeping the pushbutton switch S1 pressed for more than a few seconds is shown in Table 2.

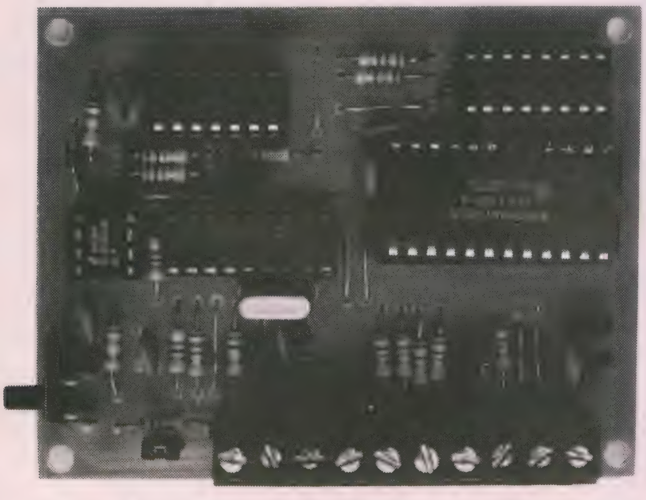
If the pushbutton is inactive for approximately ten seconds the set mode is aborted and the display returns to normal.

TRIMMING

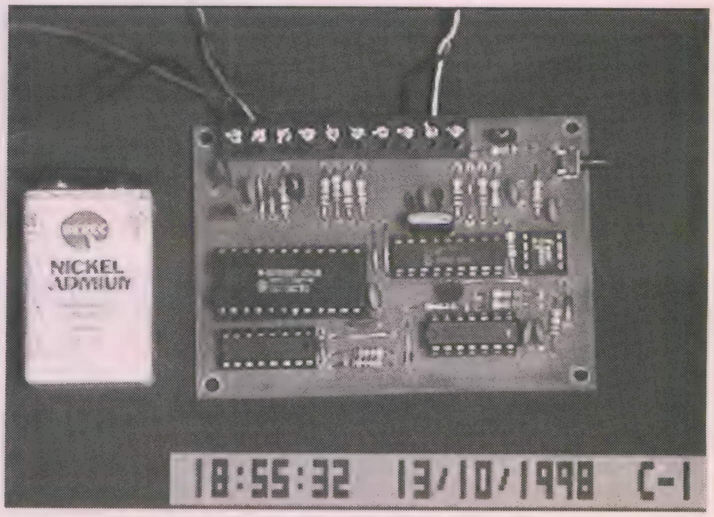
The best way to trim the real time clock is to set the trim value in the function F7 setting to zero. Adjust the clock display to read the same as a known accurate clock (e.g teletext) and leave for 24 hours. After 24 hours the clock will probably have lost or gained a few seconds. Adjust the trim value (F7) to match the number of seconds as in the following examples:

If the display is five seconds fast, set F7 to 5. If the display is nine seconds slow, set F7 to −9 (the '−' indicates minus here). This will apply the appropriate trim value to compensate for the error. Up to plus or minus nine seconds can be accommodated with this method.

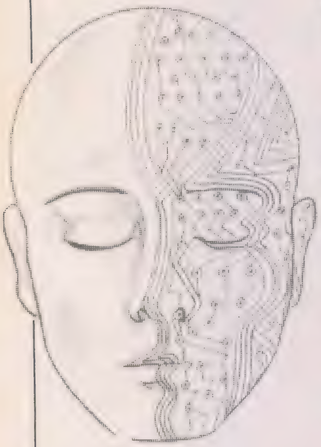
If the real time clock runs faster or slower than this the crystal oscillator X1 must be oscillating more than 100ppm fast or slow. If fast increase (try doubling) the value of capacitors C5 and C6. If slow decrease (try halving) the value of these capacitors.



Layout of components on the finished p.c.b. The pushbutton function setting switch is on the bottom-left corner.



Monitor screen shot capturing the time and date together with the "camera-on" indication (C-1).



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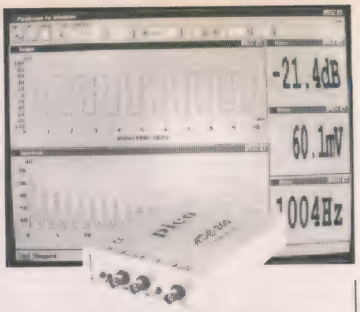

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Motor Controller With Centre Off

Pulse width modulation (PWM) provides an efficient and reliable way of controlling the speed of d.c. motors, especially at low speed. In addition to a rotary speed control, these pulse controllers often have some means of switching the motor direction.

However, the use of two controls can be cumbersome, especially if frequent direction changes are needed. One solution is to have a single rotary control configured so that in its mid-way position, the motor is stationary. Turning the control clockwise, will result in forward motion, and anti-clockwise, reverse. The speed increasing when it is advanced.

The circuit diagram presented in Fig. 1 is a PWM Motor Controller, with a centre-off facility. The first section of the circuit generates two pulse-width modulated signals, one for forward, the other reverse. The second section combines these signals to determine which direction is required and also to provide the output drive for the motor.

The pulse signals are formed by two retriggerable monostables, contained in IC2, a 4538B dual precision monostable. Both monostables (IC2a and IC2b) are triggered simultaneously by a common clock pulse provided by IC1, which is a 4047B used in astable mode. Timing components resistor R1 and capacitor C2 produce a frequency of approximately 390Hz.

When the Speed/Direction control VR1 is in the central "off" position, the time period of IC2a and IC2b will be slightly longer than that of the triggering clock pulse. Both of the inverted outputs (pins 7 and 9) will be continuously low, because both monostables will retrigger before their time elapses.

By adjusting VR1, the resistance between capacitor C3 and resistor R2 can be reduced, so the time period associated with IC2a will decrease. Since the monostable will now complete its timing before being retriggered, a square wave will appear on IC2a pin 7.

The mark-to-space ratio will be determined by how far the control VR1 is advanced. When fully advanced, only R2 (4k7) will be used to charge C3 and the time period will be about 120µs, which is approximately 4·7 per cent of the width of the clock pulse. This gives an output with a 95 per cent duty cycle.

When VR1 is turned the other way the same thing happens to the other monostable IC2b which provides the second pulse signal. Note that 4·7 kilohms is the minimum recommended value of timing resistor.

By performing a logic OR operation on the monostable outputs, a signal is produced whose duty cycle is dependent on the position of VR1. It will have a high mark-to-space ratio at either end of VR1's travel, reducing towards the middle, and completely off when centrally positioned. IC3c and IC3d (4001B quad NOR gates) are connected to provide the OR function, which is used to drive the emitter follower output stage of Darlington transistor TR2.

In Reverse

The relay RLA reverses the motor direction and is driven, via transistor TR1, by an RS flip-flop, comprising the NOR gates IC3a and IC3b. The two monostable outputs are connected to the flip-flop R and S inputs.

Since the monostables' outputs will not both be high at the same time, the output of the flip-flop will go high when the output of IC2b goes high. The flip-flop remains in this state until reset by the output of IC2a going high, which indicates a direction change, the relay then reverses the motor's rotation.

In practice it may be necessary to adjust the frequency at which IC1 oscillates, by varying the value of resistor R1. The supply voltage is not critical, and can be chosen to suit the motor used.

However, the supply must stay within the limits of the 4000B series, that is 5V to 15V, and also comply with that of the relay coil. Capacitor C1 was included to decouple the supply.

Steve Teal, Witney, Oxon.

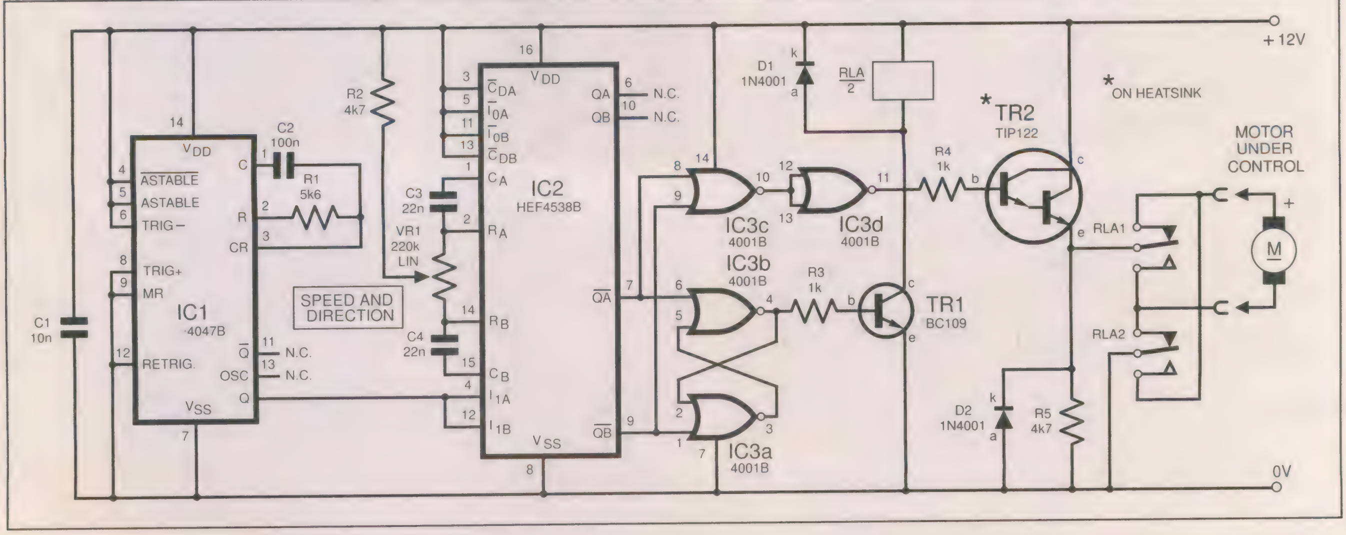

Fig. 1. Circuit diagram for a PWM Motor Controller, with centre off.

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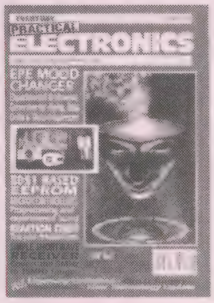

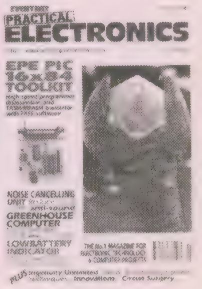

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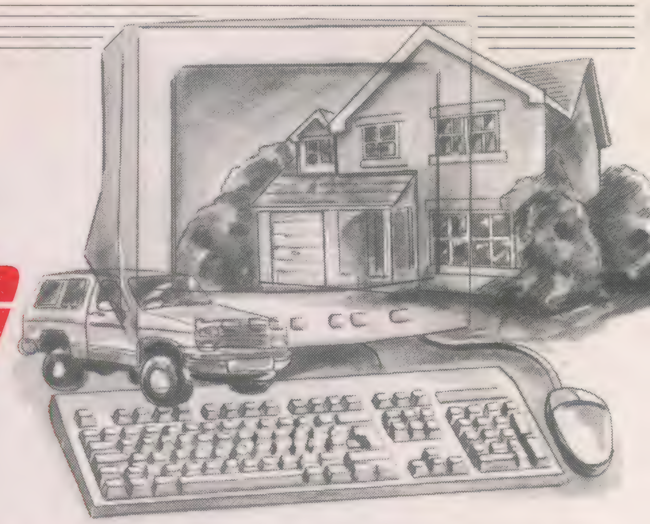


WIRELESS MONITORING SYSTEM

JAMES HUMPHRIS

Part Two

Low cost radio-linked short-range data logging is now readily and simply available.

LAST month we gave the circuits and constructional details for building an a.m. Transmitter and Receiver. This month we set about testing the system modules, consider the software and also offer the option of going f.m.

RECEIVER TESTING

It is essential to get the Receiver unit to operate correctly before the transmitter units as the latter do not have any physical indicators as to whether or not they are functioning properly.

Without a PIC inserted into the Receiver, plug in and switch on the power supply. If the voltage regulator IC1 is working correctly and there are no power supply shorts on the board, l.e.d. D3 should light.

If this is the case, then test the power connections on all the i.c.s to ensure a clean 5V supply of the correct polarity. In this state, the board should consume around 16·3mA. If it is a little higher or lower than this level then don't worry, as long as it is not excessive.

Check the COMM connection on the board near IC4, it should be at +8·7V. Also check that the case is well grounded with a continuity tester or multimeter.

Switch off the unit, carefully insert the programmed PIC and connect the serial lead between the receiver and the computer, connecting to the port that is in use at 9600 baud with 8 data bits, 1 stop bit and no parity.

Load either HyperTerminal in Windows '95 or Terminal in Windows 3.1 (or any other terminal package that is available). Check the flow control is either set to Hardware or None and the emulation is set to ANSI.

When the receiver is first switched on, l.e.d. D1 should flash briefly and the PC screen should display the message "Hello". This indicates that the unit has booted up correctly and is ready to receive r.f. signals.

If this is not the case, use an oscilloscope to check that a 3·6864MHz square wave is present on pins 15 and 16 of IC2. If this is OK, then check that IC2 pin 4 has a good 5V connection and look for a brief pulse train on pin 11 of IC2 as power is applied. If this is present, test IC4 pin 14 in the same way for a brief pulse chain of +8·4V to −8·4V.

Note that the duration of this pulse train is only five bytes at 9600 baud (5·2ms) and can easily be missed. The receiver unit must be operational before the tuning of the transmitter units as, otherwise, you could end up in a very difficult situation where nothing appears to work!

TRANSMITTER TUNING

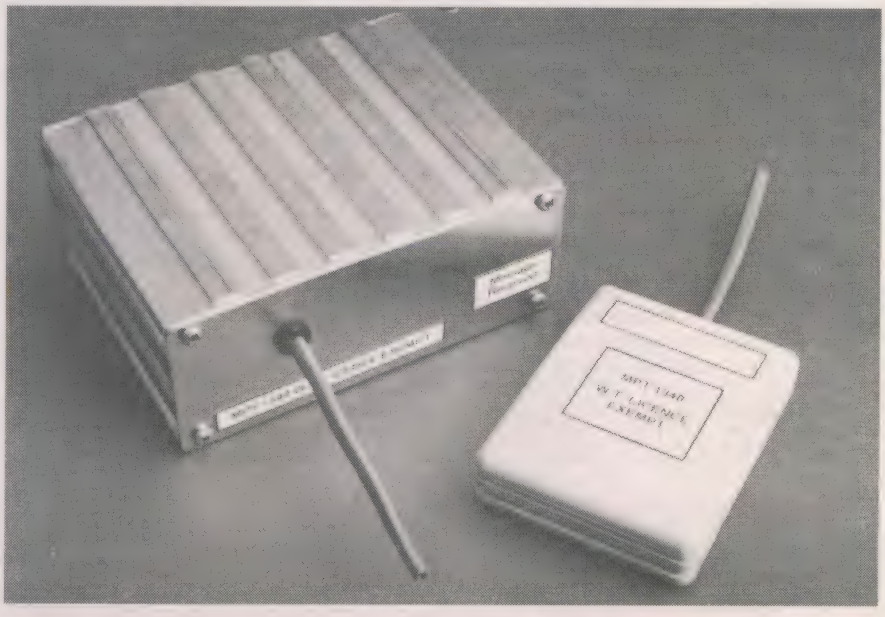
Remove the PIC from the Transmitter module and short pins 13 and 14 of its socket together using a small wire link. This supplies the transmitter module with a permanent high level so that a continuous 418MHz carrier wave is transmitted.

Switch on the receiver module and connect a multimeter measuring d.c. volts on a suitable range between ground and test point TP1. With the transmitter module switched off, a reading of around 2·6V should be obtained.

Separate the transmitter and receiver modules by a couple of metres and apply power to the transmitter. The meter reading should increase to between 2·85V and 3·15V.

Slowly adjust variable capacitor C4 on the transmitter using a non-ferrous tuning tool until the reading is maximised at around 3·15V. This may take some time and requires the separation between the units to be adjusted so that this maximum can be achieved. Remove the tuning tool and move away from the transmitter so that the best reading can be observed.

Note that best results will be achieved by using a clear line of sight between the two units. Once this has been done, switch off the transmitter, remove the temporary link and replace the PIC.



Completed Receiver module and Transmitter, with licence exempt label.

This process needs to be completed for each individual transmitter unit and once done, no further adjustments are necessary.

RADIO LINK

Although all the modulation and demodulation is completed by the r.f. modules and no particular r.f. knowledge is required, the radio link is not analogous to a length of wire linking the two units together!

Sometimes what is received is very different from what is transmitted. This is due to interference that occurs either when two transmitters attempt to transmit simultaneously, or due to other electrical appliances that generate radio frequency interference (r.f.i.) at the same frequency as the system.

All the transmitter units operate on the same r.f. channel. Therefore, if several events occur simultaneously then the channel will contain a mixture of information. An example of this is illustrated Fig.10.

If possible, the events that are being monitored should be time independent, i.e. not always occurring at the same instant in time. This is sometimes unavoidable and some transmissions will either occur together or overlap one another. The result of this is that all of the transmissions will be corrupted.

Each transmission takes only 330ms and events are usually separated by a longer period, i.e. a few seconds or minutes. Therefore, the chance of two independent events occurring at once is remote.

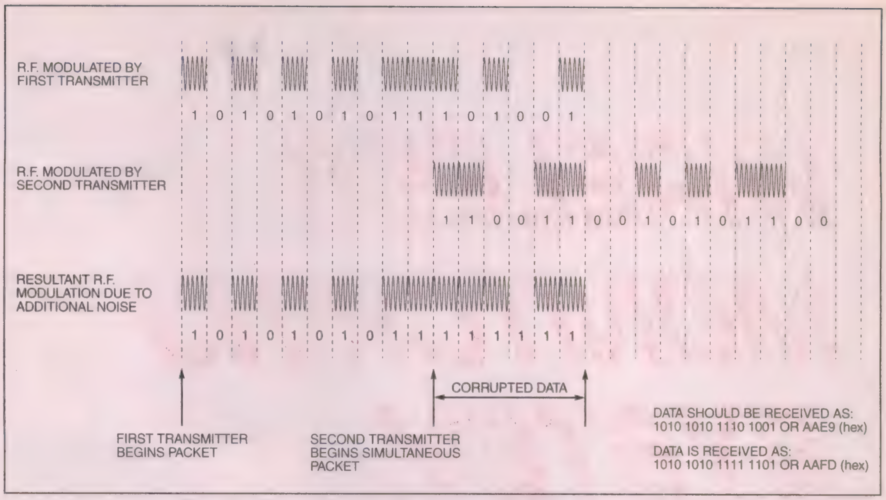

R.F. MODULATED BY FIRST TRANSMITTER
1 0 1 0 1 0 1 0 1 1 1 0 1 0 0 1
R.F. MODULATED BY SECOND TRANSMITTER
1 1 0 0 1 1 0 0 1 0 1 0 1 1 0 0
RESULTANT R.F. MODULATION DUE TO ADDITIONAL NOISE
1 0 1 0 1 0 1 0 1 1 1 1 1 1 1 1
CORRUPTED DATA
FIRST TRANSMITTER BEGINS PACKET
SECOND TRANSMITTER BEGINS SIMULTANEOUS PACKET
DATA SHOULD BE RECEIVED AS: 1010 1010 1110 1001 OR AAE9 (hex)
DATA IS RECEIVED AS: 1010 1010 1111 1101 OR AAFD (hex)

Fig.10. Example of data corruption in r.f. channel.

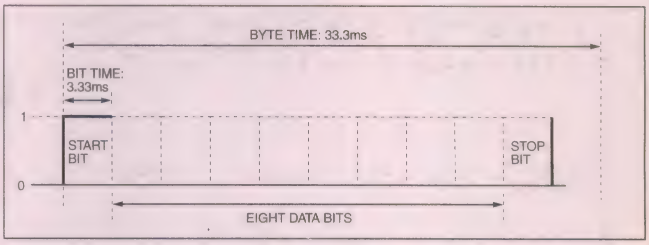


Fig.11. R.F. data byte details.

Table 1. Data Packet Description

Byte Number	Typical Value (Hex)	Description
1	55	**Synchronisation Byte** – Tells the receiver that a transmitter has started a packet and that it should wait for the rest of the packet
2	Any	**Identification Byte** – Allows the PC to identify which unit has made the transmission
3	00 to FF	**TX Number** – The number of transmissions that the unit has made (00 follows FF). This allows the PC to determine if any transmissions have been missed due to interference
4	Any	**Data 1** – Sensor level data byte 1
5	Any	**Data 2** – Sensor level data byte 2. (Not used)
6	Any	**Data 3** – Sensor level data byte 3. (Not used)
7	Any	**Data 4** – Sensor level data byte 4. (Not used)
8	Any	**Data 5** – Sensor level data byte 5. (Not used)
9	00 to 0F	**Cyclic Redundancy nibble** – Used to detect if any errors have occurred in the radio link due to interference

VALIDITY CHECKS

In order to detect if the information is corrupted, some method of checking the validity of the received data is required to be included in the data that is transmitted. It is important to realise that almost any method of data checking is not perfect and sometimes a corrupted message is interpreted as being correct. It is the software designer's responsibility to ensure that the chance of accepting an incorrect message is minimised.

The software algorithm in the transmitter modules encodes the digitised sensor information into discrete data packets that are sent across the r.f. link. Each data byte consists of ten data bits, as illustrated in Fig.11.

The high level Start Bit serves to let the receiver know that a data byte is on its way, and to prepare to receive the following eight bits that constitute the actual byte. A low level Stop Bit ensures that a short time exists between sequential data bytes and follows the eight data bits to complete each byte.

Each packet consists of nine data bytes as can be seen in Fig.12. Full descriptions of each byte are given in Table 1.

The Transmit Sync Code is used to stabilise the receiver module and allows it to lock to the correct frequency. It also serves to indicate to the receiver software that a valid transmitter module is producing the signal and not another device using the 418MHz frequency.

The Identification byte enables the PC to identify which transmitter has produced the data. The Transmit Number allows the analysis of the number of any missed data packets by the PC. The Data bytes represent the actual digitised data received by the transmitter PIC. The software only uses the first data byte but, if required, the remaining four bytes can easily be implemented by changing the PIC software. The cyclic redundancy check (CRC) nibble is mainly the method used to determine the validity of the data.

CYCLIC REDUNDANCY CHECK

The CRC nibble (half byte) is reasonably unique to each data packet and is found by performing a complex polynomial computation upon the whole data packet (excluding itself) as it is transmitted. It is essentially the remainder of a long division of the data stream by a binary polynomial.

The receiver performs exactly the same calculation on the received data stream excluding the CRC nibble and produces its own second CRC nibble. If any corruption has occurred, the second CRC will be

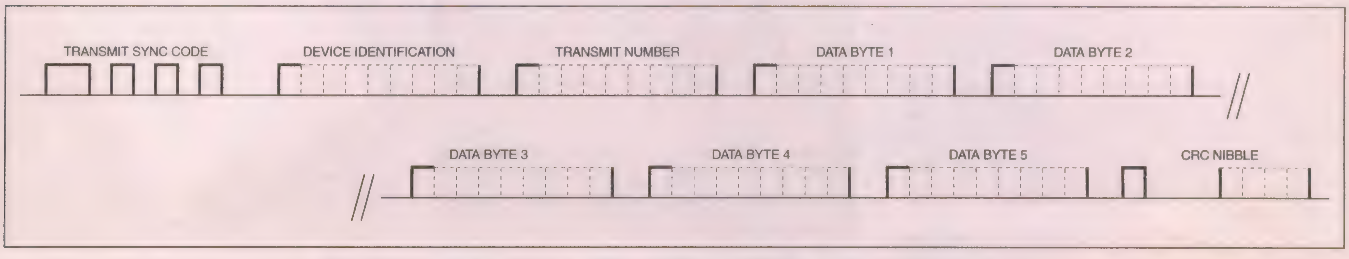
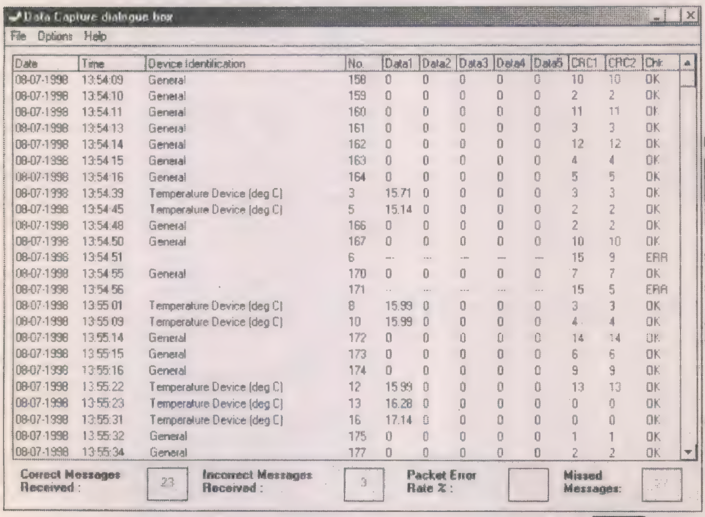


Fig.12. Breakdown information of the r.f. data packet transmission.

different to the first. Therefore, a comparison of these two nibbles determines the validity of the received data.

The CRC nibble consists of four bits and has sixteen possible values. The rest of the data packet is essentially an 80-bit binary word that has a staggering 2^{80} ($1{\cdot}208 \times 10^{24}$) values. Each of these values will correspond to one of the sixteen CRC values, i.e. each CRC value corresponds to $7{\cdot}55 \times 10^{22}$ data values.

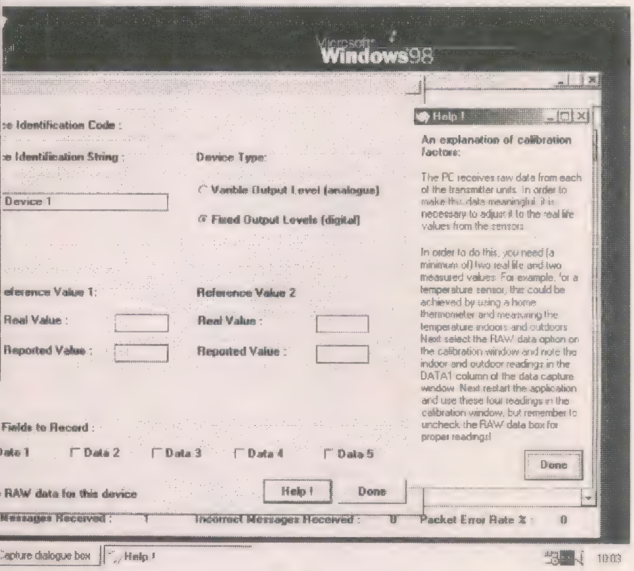
Distribution of these values is almost completely random amongst the 2^{80} possible combinations and, therefore, the chance that corrupted data produces the same CRC as the correct data stream is very slim! In fact, with the author's units, a corrupted data message has never been interpreted as correct!



Date	Time	Device Identification	No.	Data1	Data2	Data3	Data4	Data5	CRC1	CRC2	Chk
08-07-1998	13:54:09	General	158	0	0	0	0	0	10	10	OK
08-07-1998	13:54:10	General	159	0	0	0	0	0	2	2	OK
08-07-1998	13:54:11	General	160	0	0	0	0	0	11	11	OK
08-07-1998	13:54:13	General	161	0	0	0	0	0	3	3	OK
08-07-1998	13:54:14	General	162	0	0	0	0	0	12	12	OK
08-07-1998	13:54:15	General	163	0	0	0	0	0	4	4	OK
08-07-1998	13:54:16	General	164	0	0	0	0	0	5	5	OK
08-07-1998	13:54:39	Temperature Device (deg C)	3	15.71	0	0	0	0	3	3	OK
08-07-1998	13:54:45	Temperature Device (deg C)	5	15.14	0	0	0	0	2	2	OK
08-07-1998	13:54:48	General	166	0	0	0	0	0	2	2	OK
08-07-1998	13:54:50	General	167	0	0	0	0	0	10	10	OK
08-07-1996	13:54:51		6	---	---	---	---	---	15	9	ERR
08-07-1998	13:54:55	General	170	0	0	0	0	0	7	7	OK
08-07-1998	13:54:56		171	---	---	---	---	---	15	5	ERR
08-07-1998	13:55:01	Temperature Device (deg C)	8	15.99	0	0	0	0	3	3	OK
08-07-1998	13:55:09	Temperature Device (deg C)	10	15.99	0	0	0	0	4	4	OK
08-07-1998	13:55:14	General	172	0	0	0	0	0	14	14	OK
08-07-1998	13:55:15	General	173	0	0	0	0	0	6	6	OK
08-07-1998	13:55:16	General	174	0	0	0	0	0	9	9	OK
08-07-1998	13:55:22	Temperature Device (deg C)	12	15.99	0	0	0	0	13	13	OK
08-07-1998	13:55:23	Temperature Device (deg C)	13	16.28	0	0	0	0	0	0	OK
08-07-1998	13:55:31	Temperature Device (deg C)	16	17.14	0	0	0	0	0	0	OK
08-07-1998	13:55:32	General	175	0	0	0	0	0	1	1	OK
08-07-1998	13:55:34	General	177	0	0	0	0	0	2	2	OK

Correct Messages Received : 23
Incorrect Messages Received : 3
Packet Error Rate % :
Missed Messages: [illegible]

Fig.13 (left). Data capture application screen shot.



e Identification Code :
e Identification String : Device 1
Device Type:
○ Varible Output Level (analogue)
● Fixed Output Levels (digital)
eference Value 1:
Real Value :
Reported Value :
Reference Value 2
Real Value :
Reported Value :
Data Fields to Record :
☑ Data 1 ☐ Data 2 ☐ Data 3 ☐ Data 4 ☐ Data 5
☐ Use RAW data for this device
Correct Messages Received : 1
Incorrect Messages Received : 0
Packet Error Rate % : 0

An explanation of calibration factors:

The PC receives raw data from each of the transmitter units. In order to make the data meaningful it is necessary to adjust it to the real life values from the sensors.

In order to do this, you need (a minimum of) two real life and two measured values. For example, for a temperature sensor, this could be achieved by using a home thermometer and measuring the temperature indoors and outdoors. Next select the RAW data option on the calibration window and note the indoor and outdoor readings in the DATA1 column of the data capture window. Next restart the application and use these four readings in the calibration window, but remember to uncheck the RAW data box for proper readings!

Fig.14 (right). Screen shot for sensor calibration.

The receiver does not compare the two CRC values, but simply appends the second CRC nibble to the received data. This forms a ten-byte packet that is transmitted across the RS232 serial link. The raw RS232 information can be observed by using a terminal package with a hexadecimal display capability. Such a window is included in the system's software for diagnostic purposes.

SOFTWARE

When the hardware has been built and tested, the information that is received can be analysed.

The software written for this purpose is available free as detailed later. It provides a simple interface between the received data and the user's preferred spreadsheet or database application. If the spreadsheet or database that is used has the ability to collect data directly from a serial port, then this is an alternative route that can also be used for analysis.

Running the software is simple, install the package onto the PC's hard-drive (see later), start the application and a dialogue box will be displayed asking you to identify which serial port the receiver is connected to. Type in the COM port number in the box and click the mouse on Test.

The program will then test the port and ask you to switch on the receiver unit. Once the receiver's boot message has been checked, the Proceed button will be enabled and once clicked on, the main window will be displayed.

You will next be asked if you want to load the previous calibration settings. If this is the first time that you are using the software, then there are not any calibration settings stored and you must click on No.

Following this, the View options window is displayed. This allows you to select the type of time recording that you require. Full Time means that the time is recorded as the time that each message is received in 24-hour format. Similarly, Seconds Since Start or Minutes Since Start allow different types of recording depending on the frequency of messages that are anticipated.

Audible Alerts for Messages means that the PC will beep every time a message is received and is useful for testing the range of the transmitters. Clicking Done will present the main window where the messages are displayed. A typical screen shot is shown in Fig.13.

Switch on the transmitters one at a time and force a message to be transmitted by changing the condition that the sensor is used to monitor, e.g. manually induce a change in the temperature of the temperature sensor.

When a message is received from a new transmitter, the calibration window is displayed. A Help window is available from here that will help you enter the correct calibration settings for each transmitter and ensure that the data is logged in the correct manner. See Fig.14.

The Export Options window from the Options menu allows you to set-up the method that is used to export the data to a file that is subsequently used by your spreadsheet or database. This allows fully automatic exporting of data to a file every time a certain number of messages are received, or manual exporting whenever required.

The other menus available allow the message window to be cleared, the calibration settings to be deleted, the View Options window to be displayed again or hexadecimal data to be shown.

In Fig.13, the calibrated information can be seen alongside the date, time and message status. If a packet is received correctly, the last column of the table shows OK. If it is not received correctly the column shows ERR.

Statistics are calculated for the number of messages received correctly and incorrectly and a calculated current Packet Error Rate is determined. Messages that have been missed are counted and a current total is shown. The packet error rate total does not take into account any missed packets.

These statistics give an indication as to the performance of the system at any point in time and allow adjustments of the transmitters for better reception.

When you exit from the program using the File Exit menu, you will be asked if you want to save your calibration settings. This means that you can re-start the program again without having to enter in all the settings for the sensors each time. If the settings are not wanted, then click No to exit.

The graph in Fig.15 shows some sample results that have been collected from a temperature sensor transmitter unit. They correspond to the temperature of fruit juice placed in the fridge to cool down, then removed and ice added. The dots on the graph indicate the times that messages were received, i.e. when the temperature changed and a transmission occurred.

The tilt switch transmitter unit is probably most useful in testing the range of operation of the units. The advantage of the switch is that it can easily be moved and its orientation changed such that the environment within which the system is used can be explored for range and suitability.

A typical application is shown in the graph of Fig.16, where the tilt switch is used within a vehicle to monitor the opening and closing of the boot hatch. This is combined with information recorded from another sensor that is being used to monitor pulses from the odometer in order to measure distance travelled.

A laptop PC in the boot of the vehicle was used to record all the received information. This information can be used, for example, to ensure that a secure load carried in the boot of a vehicle is only accessed at particular points along a specific journey.

OPERATING RANGE

If the range of operation of the transmitter units is not acceptable for the particular application required, several methods could be implemented to increase the physical separation between the transmitter and receiver units. Two possible methods exist: replacing the radio modules with more sophisticated f.m. types and, secondly, increasing the power that is supplied to the existing a.m. transmitter module.

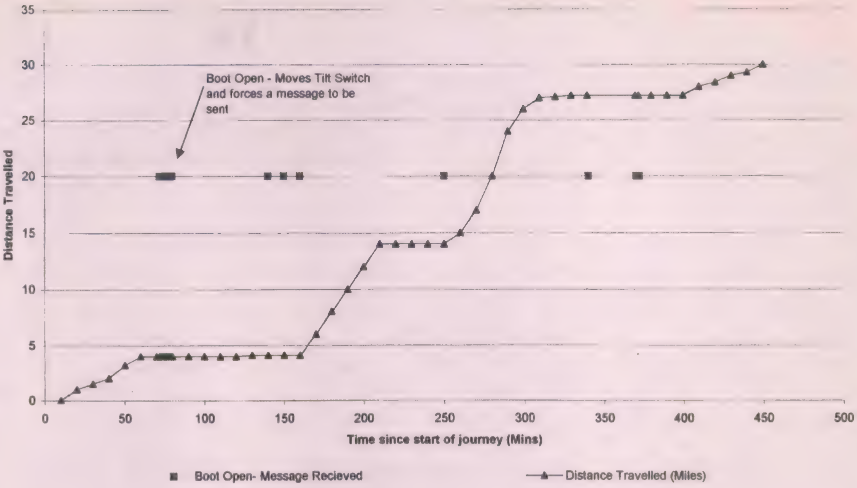


Fig.16. Graph details from a boot sensor and a distance travelled sensor.

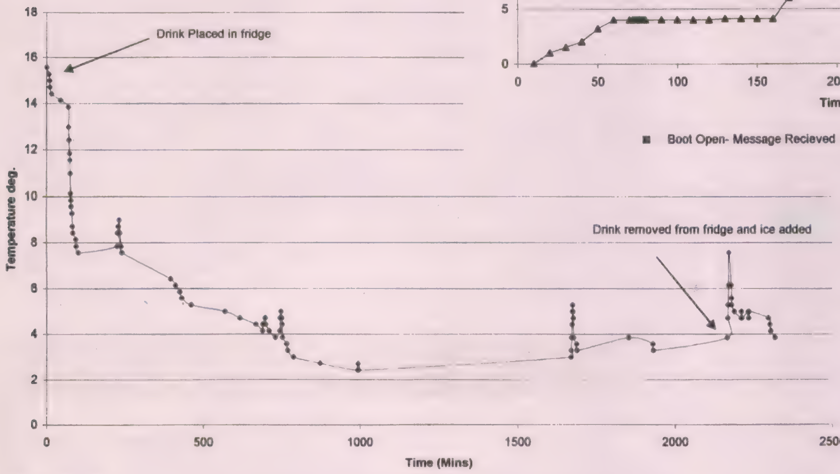


Fig.15. Sample graph of temperatures obtained from a fruit juice drink placed in a fridge.

BOOSTING A.M. POWER

An easy method of increasing the range of operation with a.m. is simply to provide the transmitter with a higher operating voltage and hence allow more current to be consumed by it. The PIC has a maximum operating voltage of 6V and, therefore, without any extra interfacing between the PIC and transmitter, this provides an upper limit on the voltage allowed. In order to limit the current that is consumed by the transmitter when running from 6V, the value of resistor R5 needs to be adjusted according to Table 2.

Table 2: Resistor R5 values according to V_{CC} voltage.

V_{cc} Min	V_{cc} Max	R5 Value (Ohms)
2·5	3·5	100
2·8	4·0	220
3·2	4·5	330
3·6	5·2	470
4·2	6·1	680
5·2	7·6	1k

Performance can be further improved by the use of a mains adaptor power supply that can provide a regulated and smoothed 5V d.c. output. This provides the transmitter with a good ground connection that cannot be achieved with the use of a floating power supply such as a battery.

SWITCHING TO F.M.

Frequency Modulation (f.m.) is considerably more reliable than the older technology, Amplitude Modulation (a.m.). This can be easily observed by listening to an a.m. radio station in a car and travelling around an urban area or under a bridge. The signal strength received is subject to variation due to buildings, hills, etc.

With f.m., however, these effects are reduced and a strong signal is either received or not received, and is reasonably independent of direction. This is true in the case suggested here also. An f.m. system, although *not* tested, would provide a significant improvement in performance and range of operation, but at an increased cost.

Switching to f.m. involves significantly more effort than increasing the power of the a.m. modules. It also consumes more power than a.m. and is not as well suited to battery operation. Consequently, f.m. is recommended only for use where greater ranges are required. Manufacturers' data sheets for f.m. modules suggest that a range of up to 200 metres free space and 30 metres worst case are possible.

F.M. RECEIVER

A modified schematic for the f.m. receiver unit is shown in Fig.17, a suitable adaptor p.c.b. is shown in Fig.18. This board is available from the *EPE PCB*

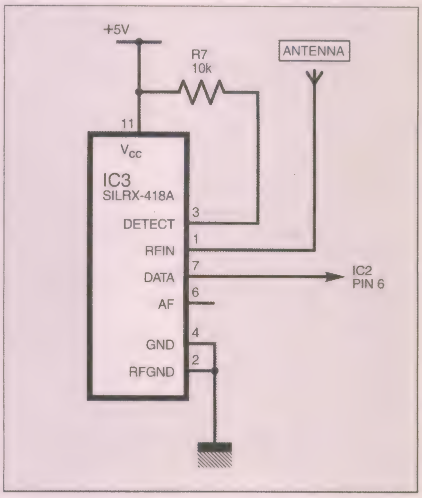
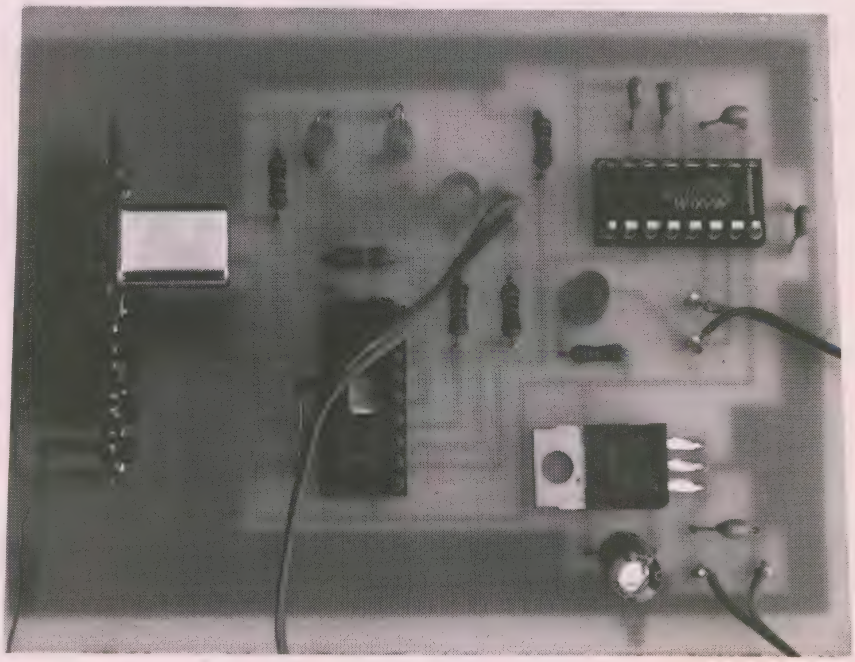


Fig.17. Receiver modification details for f.m. operation.



Completed a.m. receiver board. The f.m. adaptor p.c.b. replaces the a.m. module.

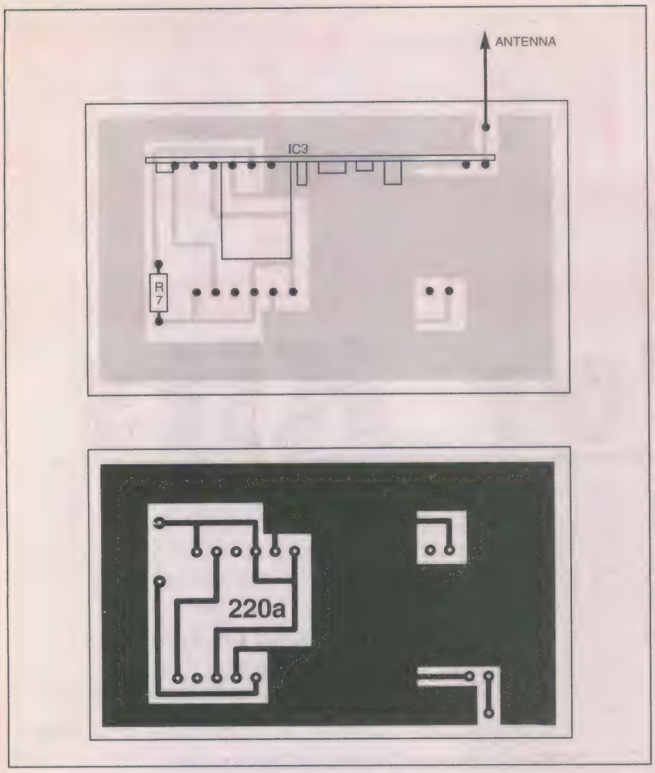


Fig.18. F.M. Receiver adaptor printed circuit board details.

Two completed Transmitters. One with a remote thermistor sensor (right-hand corner), and the other showing the required "licence exempt" label.

Service, code 220a, together with the main p.c.b.

The adaptor board allows direct replacement of the a.m. module with the f.m. type. This board should be mounted above the existing p.c.b. and connection made via pins from the a.m. receiver holes through to the matching holes in the adaptor.

The f.m. receiver should then be soldered into the adaptor board and a 10kΩ resistor soldered into the holes for R7. The antenna should be connected directly to the adaptor board and brought out through the case as normal. The f.m. module uses a more conventional quarter-wavelength short whip antenna of 170mm length.

F.M. TRANSMITTER

The modified f.m. transmitter schematic is shown in Fig.19. Capacitor C3 needs to be removed and R5 replaced with a wire link or zero ohm resistor. Components C4, L1 and IC2 also need to be removed.

The transmission adaptor p.c.b. is shown in Fig.20. This board is also available from the *EPE PCB Service*, code 119a.

The board should be connected to the main p.c.b. via short flying leads. DATA IN and GND connections are taken from the existing holes for IC2. The power should be taken directly from the battery or other convenient location on the transmitter p.c.b. The antenna must be 170mm long rather than the 90mm type described previously.

The adaptor board must be located as close to the transmitter board as possible, in order to reduce conducted interference along the ground connection.

The 3·6V supply should be replaced by a 6V type in order for the unit to operate correctly. This *must* not be exceeded or reduced, as it is the upper limit for the PIC and lower limit for the transmitter module.

It should be noted that MPT1340 is independent of the type of modulation used. That is to say, all the antenna constraints detailed previously for the a.m. system still apply and must be conformed with.

More details of the f.m. radio modules used are available from the manufacturing company's web site at: **http://www.radiometrix.co.uk/products/product1.htm**.

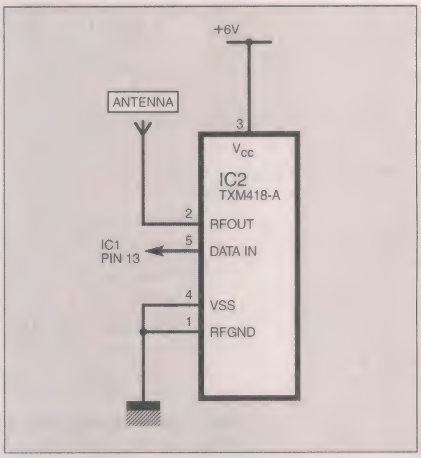


Fig.19. Transmitter modification details for f.m. operation.

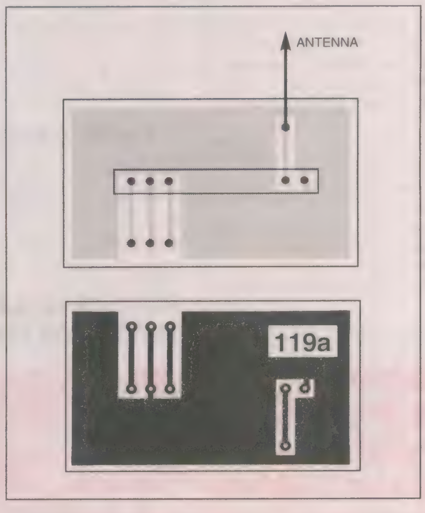


Fig.20. Full size F.M. Transmitter adaptor board details.

SOFTWARE INSTALLATION

Installation of the application software is the same as for any other Windows based application. Before installation, please ensure that all applications are closed, this includes the Microsoft Office toolbar that is easily forgotten! Then, simply double click on the file named **SETUP.EXE** and follow the on-screen instructions.

The default installation directory is **C:\EPE\**. This can be changed to install the software on any other drive or directory. Once this is completed, a Program Manager icon called Data Capture is created. The application is executed by double clicking on this icon either from the Program Manager in Windows 3.1 or the Start menu in Windows 95 or later.

If any problems are experienced during installation such as "Version Conflict" or "File in use, cannot replace" then this generally means that a later version of the same file is already installed and does not need to be replaced. If this is the case, select the Ignore or Skip buttons.

RESOURCES

Software for the Wireless Monitoring System is available on a 3·5-inch PC-compatible disk from the *EPE PCB Service* (for details see that page in this issue – the software is free but there is nominal post and handling charge for the disk). It is also available for free download from our web site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/wireless**.

Pre-programmed PIC16C71s are available, see this month's *Shoptalk* page. Information on obtaining other "special" components for this design are also given on this same page.

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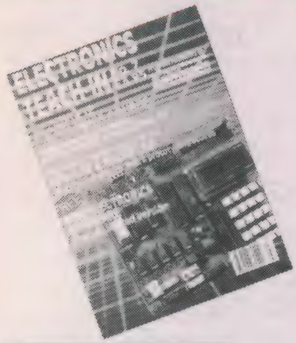

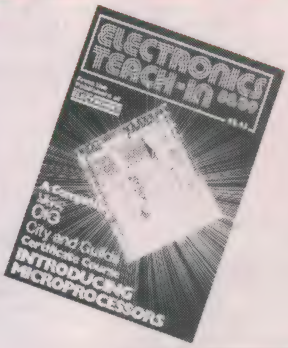

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3a

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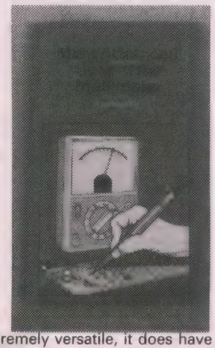

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VIDEOS ON ELECTRONICS

A range of videos (selected by EPE editorial staff) designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes originate from VCR Educational Products Co, an American supplier.

(All videos are to the UK PAL standard on VHS tapes,)

BASICS

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part One; **D.C. Circuits.** This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. **Order Code VT201**

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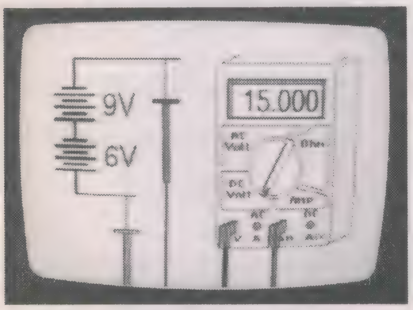

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VT103 35 minutes: A step-by-step easy to follow procedure for professionally cleaning the tape path and replacing many of the belts in most VHS VCR's. The viewer will also become familiar with the various parts found in the tape path. **Order Code VT103**

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Now for the digital series of six videos. This series is designed to provide a good grounding in digital and computer technology.

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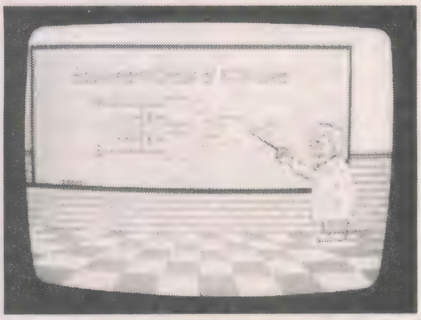

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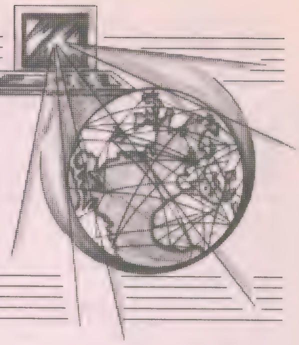
E22

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY



NET WORK is the monthly column specially written for readers who access the Internet either at home or work. Our web site **http://www.epemag.wimborne.co.uk** provides details of the contents of current and previous issues, with photographs and brief descriptions of many past projects, and the web site is as popular as ever amongst readers all around the world.

Also available on the *EPE* web site is the *EPE Chat Zone* (**/wwwboard**) which is a message board where readers and other electronics enthusiasts can air their views or ask for help from other readers. By using the fill-in form on the *Chat Zone* page, a message can be posted in virtually real time for others to follow up. It should be noted that we cannot guarantee a personal reply to any queries raised addressed to *EPE* Editorial staff by *Chat Zone* users, although we do visit at regular intervals: queries requiring a reply should be mailed to the appropriate E-mail address – see the separate panel elsewhere in this issue concerning *EPE* Net Addresses.

Messages are retained in the *Chat Zone* for approximately fourteen days subject to our discretion but follow-ups cannot be archived on our web site after they expire, so it's advisable to check back at reasonable intervals to check for any replies. The Acceptable Use Policy (AUP) is also published online and is accessible from the *Chat Zone*. It contains common sense rules which are designed to ensure that everyone enjoys their visit and may hopefully contribute to the running of the *Chat Zone*. Please follow the spirit of the AUP and help us to maintain the *EPE Chat Zone*. You benefit!

EPEMAG DOT COM

It can be taken for granted that the Internet has swiftly become an integral part of your computer system. The next generation of Microsoft's Office software suite – Microsoft Office 2000 – will include closer Internet and Intranet support than ever before. Windows NT users may be aware of the forthcoming release of Windows 2000 Professional version (see **www.microsoft.com/windows/professional/**) which also offers tighter integration with online and offline browsing. Even with the current URL-obsessed version of Microsoft Word 97, any URLs can be detected and made ''clickable'', so that the computer will make an Internet connection and go straight to that address.

Really, having an Internet connection is the same as having a giant external hard drive connected to your system. All you have to do is find the data, and learn to discriminate between what looks reliable and what is complete garbage: you soon learn how to dismiss the latter. The Internet has become almost as indispensable as a multimeter, and many local libraries or Internet cafes will be happy to help inexperienced users get to grips with it.

As far as our own Internet presence goes, *EPE* was the first hobby electronics magazine to offer an E-mail contact address all those years ago, and regular readers will know how my personal Demon Internet ''*epemag*'' moniker is now also applied to our American Internet-only version *EPE Online*, which features a downloadable version of your favourite magazine available from **www.epemag.com**. This is again a world-first and the initial reaction has been highly encouraging. The first issue published online (November '98) is permanently free for download, and each issue is contained in a series of **.PDF** files stored on your hard disk.

ADOBE ACROBAT

To view each issue of *EPE Online* you require the free Adobe Acrobat Reader which will be found on the free *EPE CD-ROM No.1* given away with the November 98 issue. Both 16-bit (Windows 3.x) and 32-bit versions for Windows 95+ are provided. Both versions are located in the **EPE/ Proteus** folder on the CD. Alternatively, you can simply bounce over to **www.adobe.com** and fetch the free reader from there. There are several **.PDF** files on the free CD-ROM as well – to find them, insert your CD-ROM then use Windows Explorer to right-click on your CD drive letter. Click Find... and enter (Files) Named : *.PDF to produce a list of them. Please ensure you are using Version 3 or higher of the Acrobat Reader.

Although Adobe Acrobat is now widely accepted as the electronic document standard, many newcomers are not familiar with such terms, and I have had several E-mails from readers who have struggled with this file format (or more specifically, how to read it properly and without facing lengthy wasted downloads).

Some examples of Adobe Acrobat files will be found on the new ''Resources'' page which has been added to the *EPE* web site (**/resources.htm**). This web page provides a list of our free FAQs and data: there you will find lead-ins to the *Basic Soldering Guide*, TENS User Page and a copy of Julyan Ilett's excellent article *How to use Intelligent L.C.D.s.* The L.C.D. article is in Adobe Acrobat format.

There are two options available to web users who are confronted by **.PDF** files such as these: having installed the free reader software (a simple task), you can click on the file name on the web page and your browser will then immediately launch the reader within the browser window. However, there can follow a lengthy delay depending on the file size, during which time the files are downloaded onto your PC, after which the document can be viewed on-screen.

A much better alternative is to fetch the file via the Internet and save it to your hard disk for viewing and printing later when offline. You can easily do this by pointing the mouse at the file name on the web page, then right-mouse click and choose (in MS Internet Explorer) Save Target As . . . or (Navigator) Save Link As... From there, navigate to a desired local directory to save the file on your hard disk. The transfer will then take place.

You can then re-open the file when offline, simply by double-clicking its filename in Windows Explorer, which should launch Adobe Acrobat Reader. Note that you may not necessarily be able to print some **.PDF** files locally – it depends whether the option to print was disabled when the file was originated by its owner. Usually, though, you can produce a hard copy for retention.

WHICH EPE MAG?

The other query which is arising is whether readers should choose between buying *EPE Online* or continue to take the printed version. There are some important differences between the two editions: one is that the projects published in *EPE Online* may not quite be the same as those in the corresponding printed issue. There may sometimes be some rescheduling of projects to fit within *EPE Online's* format.

A second difference is that the online edition is tailored to an international audience rather than being UK-centric. Hence there is little advertising within *EPE Online*, although the inclusion of advertisements has not been ruled out for the future. None-the-less, the subscription price for *EPE Online* is highly competitive – less than US $2 per issue. Whichever option you choose, we hope you'll agree that with the advent of the Internet, this is now a very exciting time to be involved in electronics.

In coming months, I will be discussing more Internet services and applications which may help *EPE* readers to get more out of the Internet. For example, I'll be examining what is probably the world's most popular software download at the moment – ICQ. I will also try to offer more advice and pointers for novice Internet users.

As usual, I have placed some ready-made links for you to click on, in the *Net Work* page of the *EPE* web site. I welcome suggestions by E-mail to **alan@epemag.demon.co.uk**. My Home Page is **http://homepages.tcp.co.uk/~alanwin**.

PCBs FROM PAST ISSUES OF ETI

(prior to the merger of EPE and ETI in March 99). See below for ordering details.

Name and issue of project	Unit code	Price
ETI PCB Service Issue 1 1999		
Stress and Skin Temperature Meter	E/0199/1	£14.55
'Short Cut' Continuity Tester	E/0199/2	£5.09
R.F. Probe	E/0199/3	£5.09
Switch Volt PSU	E/0199/4	£5.09
ETI PCB Service Issue 13 1998		
Programmable Logic Microcontroller Board	E/1398/1	£7.32
Programmable Logic Simulator Board	E/1398/2	£5.09
Regulated Battery PSU	E/1398/3	£5.09
Audio Power Meter	E/1398/4	£7.32
Car Vigilante	E/1398/5	£5.64
Millivolt Meter	E/1398/6	£6.77
Wobbulator	E/1398/7	£6.22
ETI PCB Service Issue 12 1998		
Beerstat	E/1298/1	£5.09
Fishbiter	E/1298/2	£5.09
Smooth Fuzz	E/1298/3	£5.09
ETI PCB Service Issue 11 1998		
Loop Alarm	E/1198/1	£5.09
Ricky Sound (Music Lovers)	E/1198/2	£5.09
ETI PCB Service Issue 10 1998		
Ionisation Chamber	E/1098/1	£5.09
Ionisation Chamber (SMD)	E/1098/2	£5.09
PIC Development Board: see also issue 6 below	E/698/1	£5.50
ETI PCB Service Issue 9 1998		
Q Meter	E/998/2	£5.09
Bath Duck	E/998/3	£5.09
ETI PCB Service Issue 8 1998		
PIC Electronics Security Switch	E/898/1	£5.09
PIC Multiplexed LED Display	E/898/2	£5.09
PIC Non-multiplexed LED Dispay	E/898/3	£5.09
Easy Parker	E/898/4	£6.77
Tiny Traffic Lights	E/898/5	£5.09
Q Meter	E/898/6	£5.09
Bath Duck	E/898/7	£5.50
ETI PCB Service Issue 7 1998		
PIC 16C74 Development Board	E/798/1	£5.09
Surface Mount Diagnostic Interface	E/798/2	£5.09
Surface Mount Logic probe	E/798/3	£5.09
Mains Monitor	E/798/4	£12.33
Aquaprobe	E/798/5	£5.50
ETI PCB Service Issue 6 1998		
PIC Development Board	E/698/1	£5.50
Signal Generator	E/698/2	£8.99
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6-Interval Games Timer	E/698/4	£5.09
ETI PCB Service Issue 5 1998		
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UHF Transmitter Encoder	E/598/2	£5.09
UHF Receiver Front End (DS)	E/598/3	£5.07
UHF Receiver I.F. stage (DS)	E/598/4	£5.07
Fridge Thermometer	E/598/5	£5.50
AVR Controller	E/598/6	£5.50
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Guardian Light	E/598/9	£6.22
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BB Ranger Control Board	E/498/2	£6.22
BB Ranger Score Board	E/498/3	£22.89
Line-Up Oscillator with Glitch	E/498/4	£8.99
Tic-Tac-Toe	E/498/5	£8.44
ETI PCB Service Issue 3 1998		
Medium Wave Loop	E/398/1	£5.64
AA Cell Eliminator	E/398/2	£7.32
PIC Based Double Bass Tuner	E/398/3	£5.64
5-range Capacitor Meter	E/398/4	£6.77
MIDI Drum Pads	E/398/5	£5.64
ETI PCB Service Issue 2 1998		
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Smartcam opto-sensor board	E/298/2	£5.09
Both smartcam boards	E/298/1&2	£7.00
Switched Mode Internal Power Supply	E/298/5	£7.87
Auto Cupboard light	E/298/3	£5.64
ETI PCB Service Issue 1 1998		
Control Centre Desk-Top unit	E/198/1	£8.99
Control Centre Main Section	E/198/2	£7.87

PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service,** ***Everyday Practical Electronics,*** **Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749; Fax 01202 841692 (NOTE, we cannot reply to orders or queries by Fax); E-mail: orders@epemag.wimborne.co.uk .** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

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Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

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We have a few p.c.b.s left from past projects these are being offered at the knock down price of **£2.00** each – *no matter what size they are* **(some of these boards are worth over £15.00 each)** while stocks last. This price includes VAT and UK post – overseas orders please add 50p postage (or £1 per board for airmail postage).

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Vandata – Boot Control Unit		953	£10.52
Display Unit		954	£6.61
Sound Switch	**OCT'95**	915	£6.55
Multiple Project PCB		932	£3.00
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Treble Booster			
Infra-Red Controller/Alarm (2 boards required)			
Capacitor Check		955	£5.76
Ginormous VU Meter		956	£9.31
Multiple Project PCB	**NOV'95**	932	£3.00
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Digital Delay Line		958	£8.04
50Hz Field Meter		959	£8.32
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Stereo "Cordless " Headphones	**DEC'95**		
Transmitter		961	£8.04
Receiver		962	£7.66
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∗PulStar		998	£6.60
VU Display and Alarm		999	£7.02

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and Counter – Oscillator/L.C.D. Driver	994/995 (pr)	£12.72
Timed NiCad Charger	100	£6.99
Single-Station Radio 4 Tuner	101	£7.02
Twin-Beam Infra-Red Alarm –Transmitter/Receiver	102/103 (pr)	£10.50
✻Games Compendium	104	£6.09
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– Transmitter/Receiver	990/991 (pr)	£10.16
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– Receiver	143	£6.04
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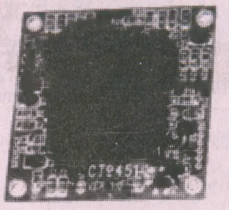

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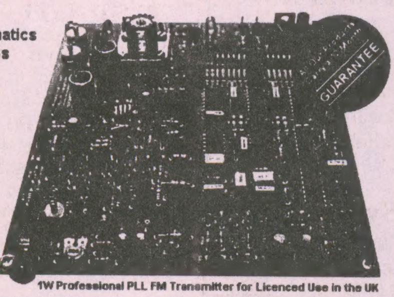

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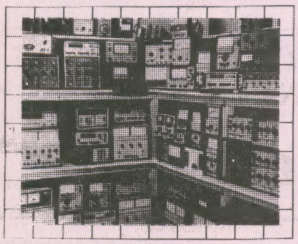

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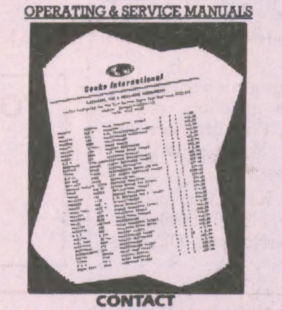

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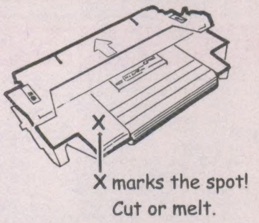
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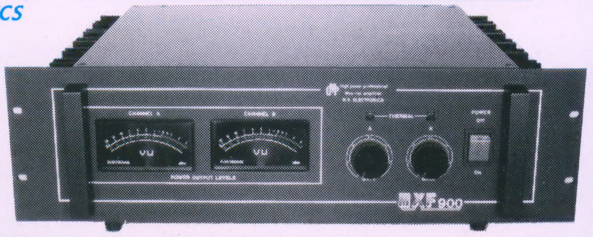

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FOUR MODELS:- **MXF200** (100W + 100W) **MXF400** (200W + 200W)
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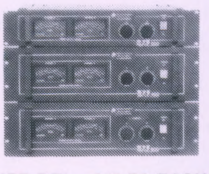
TURES: ★ Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu Meters vel controls ★ Illuminated on/off switch ★ Jack/XLR inputs ★ Speakon outputs ★ Standard 775mV s ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. peaker and thermal protection.

) THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC

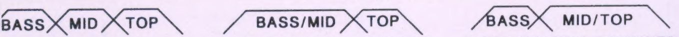


SIZES:-	MXF200	W19"	D11"	H3½" (2U)
	MXF400	W19"	D12"	H5¼" (3U)
	MXF600	W19"	D13"	H5¼" (3U)
	MXF900	W19"	D14¾"	H5¼" (3U)

RICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

XO3-S STEREO 3-WAY ACTIVE CROSS-OVER SWITCHABLE 2-WAY



CONFIGURED 3 WAY
2 WAY BASS/MID COMBINED
2 WAY MID/TOP COMBINED

TURES:

nced 3-Way Stereo Active Cross-Over (switchable two way), housed in a 19" x 1U case. Each channel hree level controls: Bass, Mid & Top. The removable front fascia allows access to the programmable DIL hes to adjust the cross-over frequency: Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5Hz, all at 24dB per e. The 2/3 way selector switches are also accessed by removing the front fascia. Each stereo channel be configured separately. Bass Invert Switches are incorporated on each channel. Nominal 775mV /output. Fully compatible with OMP Rack Amplifier and Modules.

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TURES:

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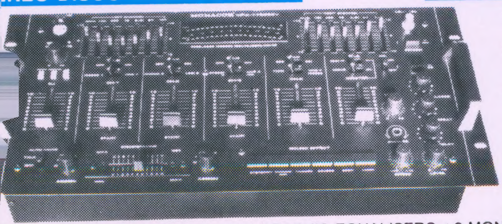
EREO DISCO MIXER MPX-7700 ECHO & SOUND EFFECTS



- ★ 4 STEREO INPUT CHANNELS
- ★ 2 DJ MIC INPUT CHANNELS
- ★ 2X7 BAND GRAPHIC EQUALISERS
- ★ HEADPHONE MONITOR WITH PFL
- ★ ASSIGNABLE CROSSFADE
- ★ DIGITAL ECHO

EREO DISCO MIXER WITH:- ★2X7 GRAPHIC EQUALISERS ★2 MONO MIC INPUTS ★DJ MIC H FADER, TALKOVER AND VOICE CHANGER ★4 STEREO CHANNELS WITH INDIVIDUAL ERS AND ASSIGNABLE CROSSFADE ★CHANNELS SWITCHABLE, TURNTABLE (MAG RTRIDGE), CD, LINE, TAPE, ETC. ★ECHO WITH BALANCE, REPEAT AND DELAY EADPHONE MONITOR WITH PREFADE LISTEN ★CHOICE OF 6 SOUND EFFECTS ★STEREO NO SWITCH ★2 X LED VU METERS ★MASTER FADER ★OUTPUT 775mV ZE:- 482X240X115mm ★POWER:- 230V AC 50/60Hz. **PRICE:- £169.00 + £5.00 P&P**

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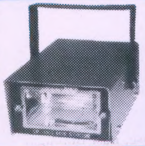

op quality mini strobe with high light intensity for its size and variable h rate adjustment. Housed in a silver/black steel case with adjustable unting bracket. ★ Flash Rate:- Adjustable from zero to ten flashes per cond ★ Mains Powered complete with plugged lead ★ 230V AC 50/60Hz ize:- 125 X 84 X 52mm **PRICE:- £19.99 + £2.20 P&P**

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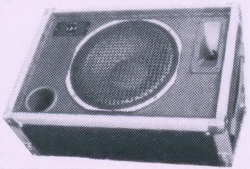
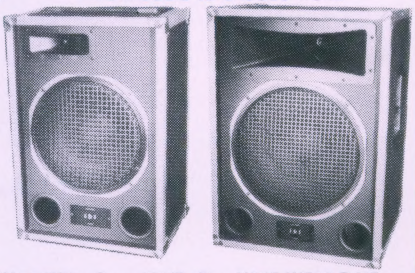
WEDGE MONITOR





PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET.
ALL ENCLOSURES ARE 8 OHM.

15=15 inch speaker
12=12 inch speaker

ibl FC15-300 WATTS Freq Range 35Hz-20KHz, Sens 101dB, Size H695 W502 D415mm
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ibl FC12-300 WATTS Freq Range 45Hz-20KHz, Sens 96dB, Size H600 W405 D300mm
PRICE:- £249.00 per pair

ibl FC12-200 WATTS Freq Range 40Hz-20KHz, Sens 97dB, Size H600 W405 D300mm
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ibl WM12-200 WATTS Freq Range 40Hz-20KHz, Sens 97dB, Size H418 W600 D385mm
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Size:- H405 W455 D305mm.

PRICE:- £79.00 + £6.00P&P

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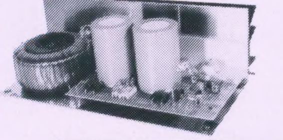
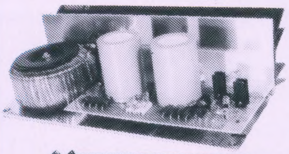
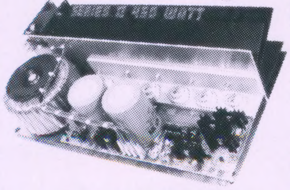
PRICE:- £42.85 + £4.00 P&P



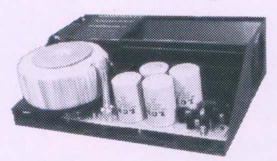
OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB. Size 300 x 155 x 100mm.
PRICE:- £66.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB. Size 330 x 175 x 100mm.
PRICE:- £83.75 + £5.00 P&P



OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE:- £135.85 +£6.00 P&P



OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE:- £261.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. **ORDER STANDARD OR PEC**

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